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Mechanical Equipment at Point-No-Point

DETAILS OF COAL, WATER AND STEAM HANDLING AT THE ESSEX PLANT OF THE PUBLIC SERVICE ELECTRIC CO. OF NEW JERSEY

BECAUSE OF THE NOVELTY of many features of the arrangement and the importance of the plant, it seems desirable to describe still further the detail of the Essex plant of the Public Service Electric Co. of New Jersey, and in the article herewith will be taken up the mechanical equipment.

To get a clear understanding of the arrangement and purposes of the machinery, it seems desirable to follow the course of the 2 fundamental materials which enter into the operation of a power plant, namely, the coal and the water. In following the course of the coal, there will naturally be included the methods for handling ashes and flue gases, and in taking up the journey of the water through the plant, will come in the handling of

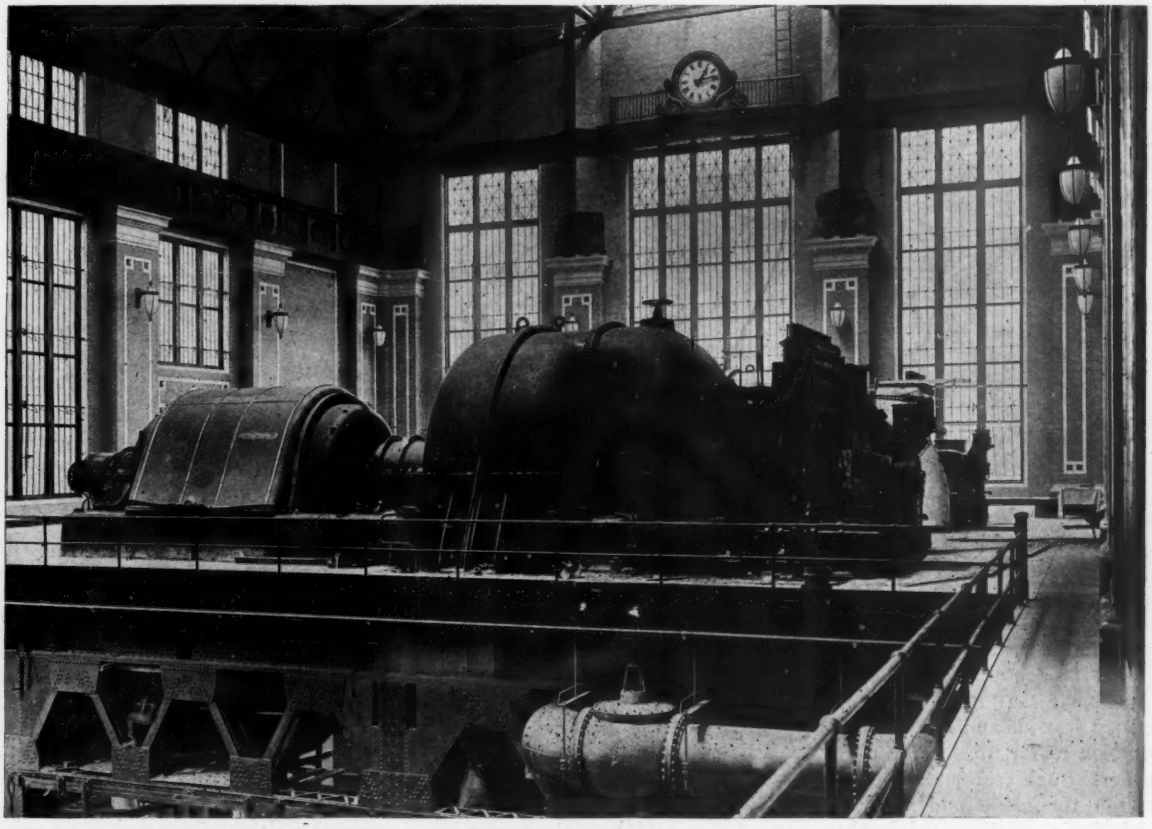


FIG. 11. TURBINE ROOM

cooling water for the condensing plant, as well as the feed water used in the boilers.

Coal Handling

As outlined in the previous article, arrangements are provided for taking coal either from barges in the river or from cars on the switch tracks from the adjacent railroads. In the final arrangements coal from barges will be handled by the buckets from the needle tower. The tower, arrangement of which is illustrated in Fig. 1, is the largest electric driven tower now in use. It has a height of 215 ft. from the base datum level, and a lift of 156 ft., with a capacity of 180 tons per hour, using a 1½-ton clamshell bucket. For rapid work and when larger barges are available, a 2 or 2½-ton bucket can be substituted with consequent increase in capacity. The hoisting engine is of the 2-drum type, with 24-in. drums, running at 200 r.p.m., supplied by the Maine Electric Co., and is driven by a 410-hp. induction motor direct connected to the engine. The traversing engine is of the single drum type, with 30-in. drum, driven by a 75-hp. induction motor, both motors being furnished by the General Electric Co. The lift speed is 1300 ft. per min., and the lowering speed somewhat faster, the motor acting as a generator and feeding current back to the line while the bucket drops.

Coal is deposited by these buckets in a receiving hopper near the top of the tower, and is carried by an apron, 5 ft. wide and 16 ft. long, gear-driven by a 7.5-hp. induction motor, to a grille over which it passes to the crusher. Such coal as is of less than standard size passes through the grille and goes directly to the conveyor which feeds the overhead bunker. The apron for this carry was supplied by the Stephens-Adamson Co.

The crusher is of the 2-roll type, the rolls being 36 in. diameter, furnished by the Robins Conveying Belt Co., and is driven by a 35-hp. constant speed General Electric induction motor. A duplicate crusher is provided for extra capacity, for emergency or in case of repairs. From the crusher the coal passes to belt conveyors supplied by the Robins Conveying Belt Co., one belt being 30 in. wide and 161 ft. long, and another one 30 in. wide and 120 ft. long. The capacity of the first is 300 tons an hour, driven by a 20-hp. constant speed Westinghouse induction motor; the second conveyor has a capacity of 200 tons per hour, driven by a 10-hp. constant speed Westinghouse induction motor.

Both belt conveyors are controlled by push button stops located at certain convenient points, and the control is automatic, of such nature that the conveyors cannot be restarted until the button which was used in stopping the belt has been reset, thus avoiding any danger of a restart while the conveyor is being cleared of obstruction. Provision is made for dumping from the conveyor at any desired point into any part of the bunker, or the discharge can be into chutes at the end of the conveyor run, which deliver the coal to the storage yard.

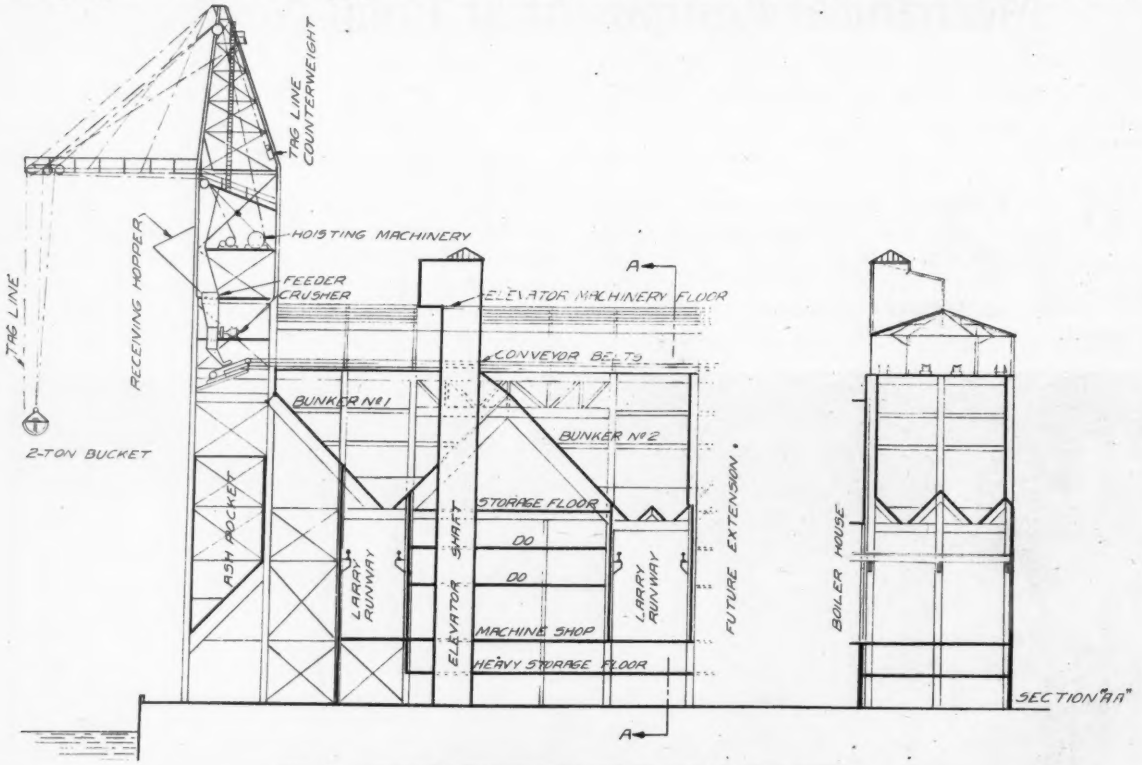


FIG. 1. ARRANGEMENT OF COAL TOWER AND BUNKER HOUSE

In the final plan, arrangement will be made for handling coal direct from barges or cars to the storage without passing through the crusher, but at the present time, coal is handled from the cars to the storage pile, or to the apron of the conveyor by locomotive cranes. Coal will be handled from the cars to the coal bunker by a balanced automatic skip hoist, having buckets of 2-tons capacity each and a total capacity of 100 tons an hour, the motor for driving this skip hoist being 25-hp. constant speed General Electric induction type. In addi-

tion to this hoisting equipment, there is in the boiler house a 7.5-ton freight elevator furnished by the Reedy Elevator Co., running at a speed of 50 ft. per minute and driven by a Lincoln Electric Co., 40-hp. constant speed induction motor.

Coal Bunker

The bunker, which is of 2000-tons capacity, is of reinforced concrete, carried on the structural steelwork of the building. The vertical walls are reinforced with No. 8 iron wires, set vertically 12 in. on centers, and No. 1 wires set horizontally 2 in. and 3 in. centers. The walls are 8 in. thick and are reinforced at several points by channel iron and heavy corbels. Near the base of the vertical walls is a channel iron riveted to a horizontal I-beam, which carries the weight of the vertical structure and is so arranged as to permit of vertical expansion above this point without influencing the structural steelwork.

Inside the bunker a ladder is provided to permit of access to the interior of the bunker for any necessary inspection or repairs. At the bottom the bunker is sloped in 2 ways, as indicated in Fig. 2, the sloping walls of the bottom being carried on heavy I-beam construction and being of the same thickness as the vertical walls, namely, 8 in. The reinforcement is, however, different and consists of ⅝-in. square twisted rods set 7 in. centers on the first and second panels, 9 in. centers on the third panel from the bottom, and 11 in. centers on the top panel.

Stiffening girders and columns of structural steel are employed in the interior of the bunker, as indicated in Fig. 2, all steelwork being covered with a 3-in. coating of concrete laid on expanded metal, and with the tops of the girders beveled to avoid lodging of coal.

Above the bunker is a monitor for housing the conveyor, the sides and roof being of No. 22 gage corrugated iron covered with asbestos and carried on steel side framing and roof trusses. At the sides, the monitor is lighted and ventilated by pivoted steel sash, and at one side a railed walkway is built from which access is had to the ladder already mentioned. The height of the vertical walls is 38 ft. 2 in., the height of the turret 20 ft., the width between vertical walls, 40 ft. 2 in., the distance from the vertical wall to the top of the long slope, 43 ft., and the angle of the sloping walls about 45 deg.

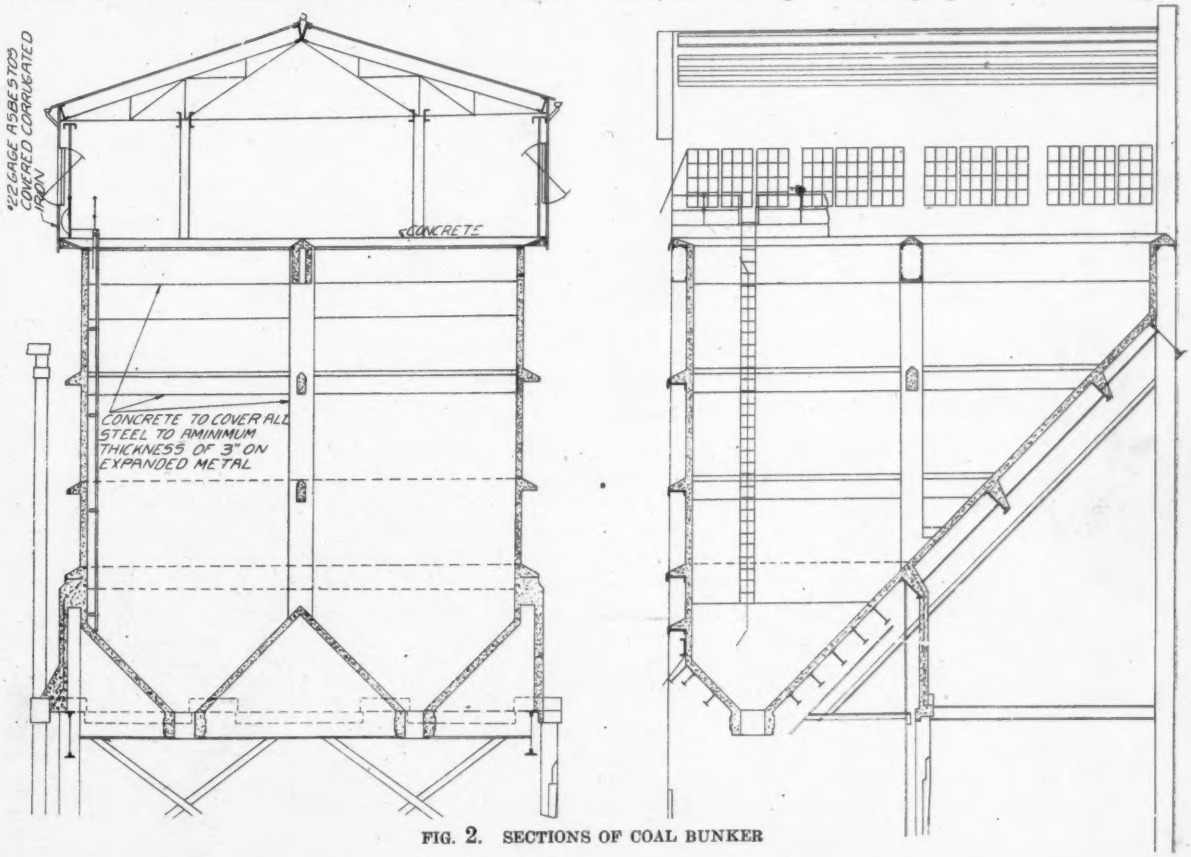

#22 GAGE ASBESTOS COVERED CORRUGATED IRON
CONCRETE
CONCRETE TO COVER ALL STEEL TO A MINIMUM THICKNESS OF 3" ON EXPANDED METAL

FIG. 2. SECTIONS OF COAL BUNKER

From the bunker coal is fed by gravity to larries, Figs. 3 and 5, which travel in the firing aisles of the boiler room. Each larry has a capacity of 15 tons, is motor driven, controlled by an operator whose cage is on the larry, and weighs automatically into the 7-ton hoppers installed on the front of each boiler. These larries were installed by the Robins Conveying Belt Co., have a 150-ft. travel per minute, driven by an 11-hp. Westinghouse motor, and have hand traverse provided for emergency operation. The arrangement of the larry and the method of feeding to the boiler hoppers is indicated in Fig. 3.

In each boiler hopper an agitator is installed driven from the stoker drive shaft to avoid any possible packing of coal, which drops from the boiler hoppers to the stoker hoppers by gravity.

Stoker Drive

The stoker equipment, furnished by the Sanford Riley Stoker Co., Ltd., is of underfeed type, the details of the stoker proper being shown in the article in the September 1 issue. Figure 4 illustrates somewhat

FIG. 3. BOILER FRONT AND LARRY

in detail the method of driving, the installation being shown for 2 of the boilers. On a platform 7 ft. above the boiler room floor are installed the motor drive equipments. For 2 boilers of each set of 4, 12-hp. General Electric induction motors are installed driving a jack shaft by means of a ¾ by 3-in. silent chain, and from this jack shaft to the stoker drive shaft by 1¼-in. pitch roller chain. The motor has 4 speeds, giving a drive shaft speed range of from 97 up to 290 r.p.m., the sprocket wheel on the drive shaft being thrown in by means of a clutch. This drive shaft is constructed in 4 sections, one for each boiler, with square-jaw clutch connections between the sections, and a drive is provided by means of 1-in. pitch roller sprocket chain from this shaft to the stoker sprocket on each gear box, the stoker for each boiler has 16 retorts driven from 3 gear boxes, each end box driving 5 retorts and the center box driving 6. The 2 inside boilers of each set of 4 have likewise each a 12-hp. motor, but it drives to a Reeves multiple speed transmission having a speed ratio of 3 to 1, thus permitting a main drive shaft speed of from 32 to 290 r.p.m., equivalent to a coal feed of from 1600 up to 15,000 lb. per hour per boiler. Connection from the motor to the Reeves transmission is through ¾ by 3-in. silent chain, and from the transmission to the main drive shaft by means of 1¼-in. pitch roller sprocket chain, the sprocket on the main drive shaft being connected by clutch as in the other style of drive.

By this arrangement, any stoker may be driven from any one of the motor installations, or each boiler may be served by its own motor, the general plan being that the 2 outside boilers with jack shaft drive will carry the steady load and the inside boilers, with variable speed drive, will be used for meeting the fluctuations.

Ash Handling

Arrangement of the furnaces and the upper part of the ash hoppers was shown in Fig. 19 in the September 1 issue. The fine coal which may drop through the stoker is caught in a pit below the stoker and may be hauled out through openings to the ash cars below and returned to the coal bunkers. Ashes and such clinker as may form are discharged over the end of the dump plate to the ash hopper, which has sloping sides and discharges, by means of sliding gate valves controlled and operated by compressed air, direct to the cars in the basement. These cars are hauled out over industrial railway tracks by Baldwin-Westinghouse electric locomotives of 5 tons capacity, and are used for filling in about the plant. When no longer required for this purpose, they will be raised by a skip hoist to a bunker in the coal tower and discharged to barges. Soot and ashes which may collect in the base of the stack or in the sub-base of the economizers are removed by a Parsons steam ejector, which discharges at present out upon the meadows for filling, but may be discharged to the ash cars and taken to the barges the same as the other ashes. This ejector discharges through a 6-in. pipe line and uses superheated steam, maintaining a suction of 4 in. of mercury in the inlet when in operation.

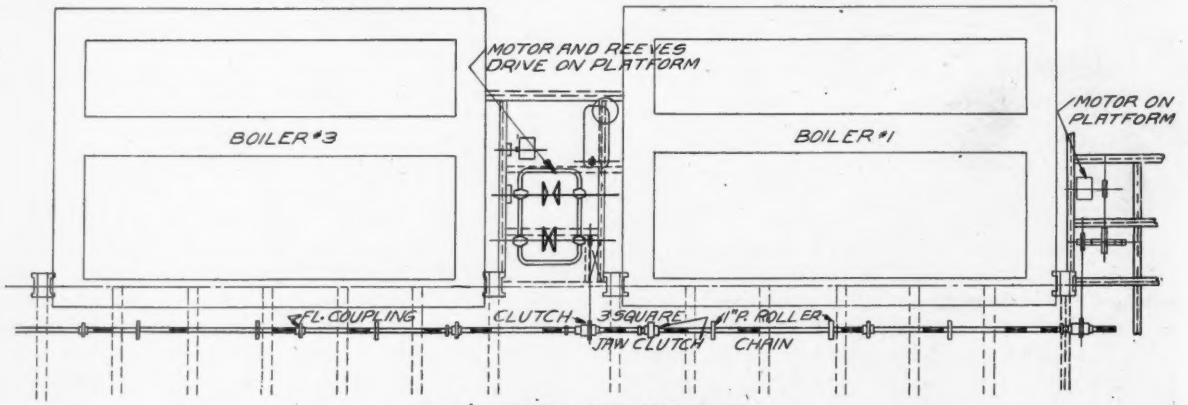


FIG. 4. SCHEME OF STOKER DRIVE

Draft

Three provisions are made for securing a satisfactory draft; first, by means of forced draft fans which discharge into a duct running beneath the boiler floor and opening into the air boxes of the stokers; second, by induced draft fans located at the ends of the economizers and discharging into the stacks; third, by means of natural draft stacks, which will carry light loads or normal loads when the economizers are not in use.

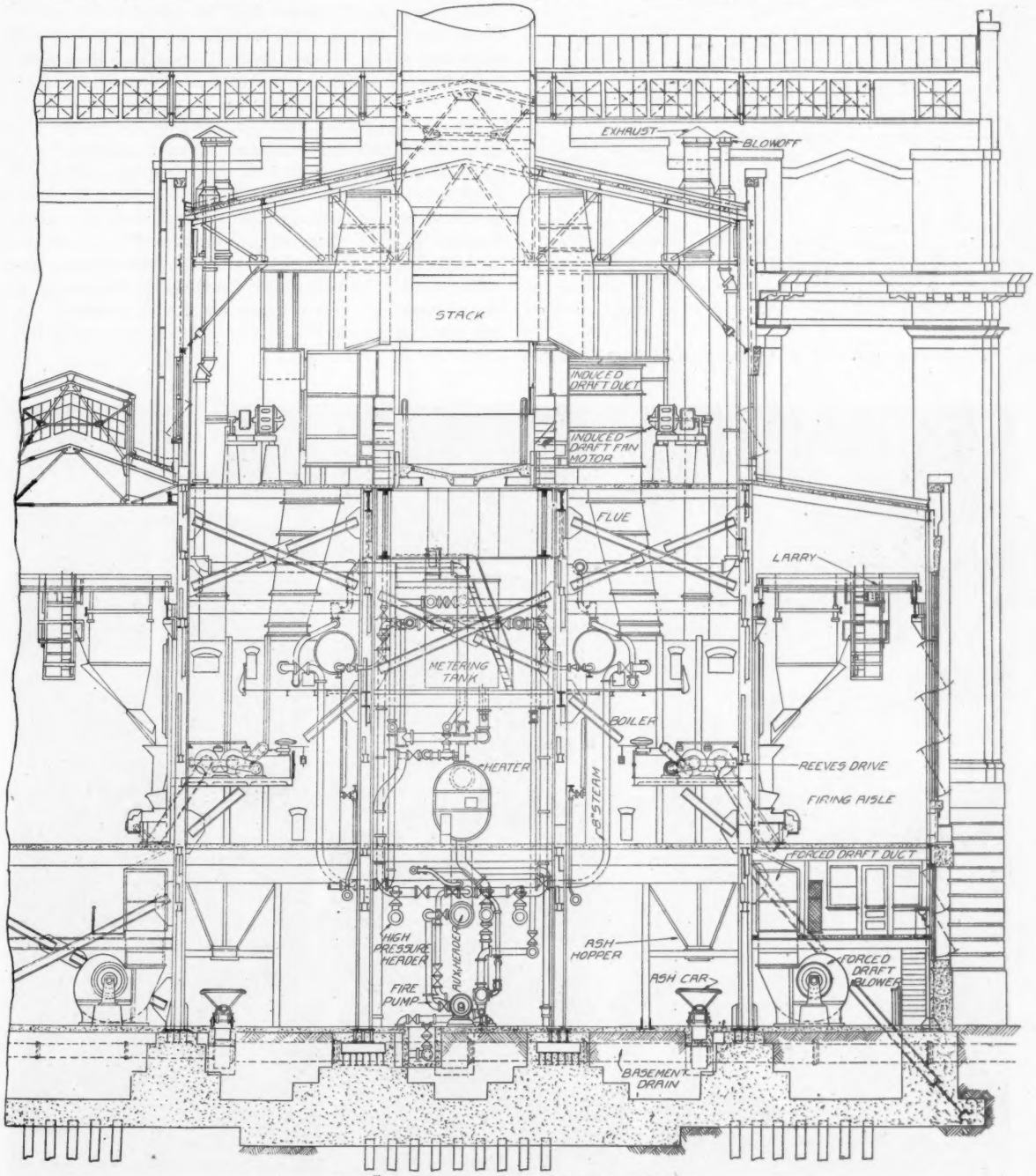


FIG. 5. SECTION THROUGH BOILER HOUSE

For the forced draft equipment, 4 Turbovane blowers are installed, furnished by B. F. Sturtevant Co., and located on the basement floor. Each has a capacity of 60,000 cu. ft. of air per minute at 7 in. water pressure, and is driven by a General Electric 150-hp. induction motor having 2 speeds, 900 and 1200 r.p.m. The fans have open inlet, taking air from the basement, one of them having its inlet opposite the discharge from the generator cooling duct, and thus taking heated air sufficient to give a 10-deg. rise to all the air used for the 4 boilers. From the forced draft duct, flues lead to the stoker wind box, each box having 4 connections in order that they may clear the I-beams. One set of 2 pipes is controlled by a damper and Mason regulator, the range of control being from wide open when steam is at

the low-pressure limit to fully closed when steam has reached the high-pressure limit. The pressure in the air chamber of the stoker acts on a flexible diaphragm, and through gears moves the shift screws of the Reeves

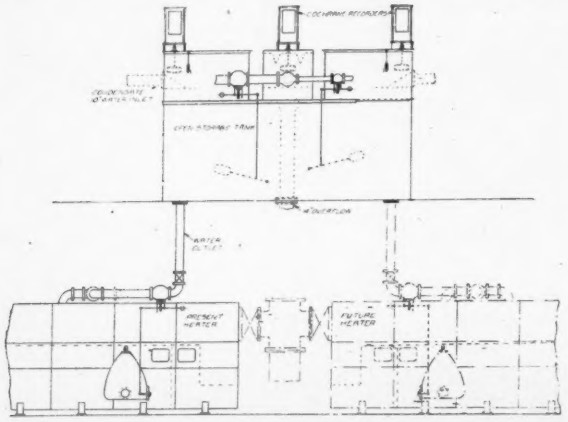


FIG. 6. ARRANGEMENT OF METERING TANKS AND HEATERS

damper opens, due to the lowering of steam pressure. The air feed and coal feed are thus automatically controlled together.

The second set of 2 connections from the forced draft duct to the stoker air box is hand controlled, and at present is used only when banking or shutting down. Later this second damper will be controlled by a balanced draft system and will be closed automatically when the uptake damper is wide open and the combustion chamber draft has reached a value of 0.1 in. of water.

The induced draft fans, of which one is installed for each boiler, are of Multivane type, furnished by the B. F. Sturtevant Co., each having a capacity of 106,000 cu. ft. of gas per minute at 400 deg. F. They are driven by General Electric constant speed, 100-hp. motors through a silent chain drive and give 2 in. suction in the uptake from the boilers. They draw the gases through the economizer and discharge to the stacks, but are arranged so that the gases may be bypassed direct from the uptake to the stacks, cutting out the induced draft fan and economizer.

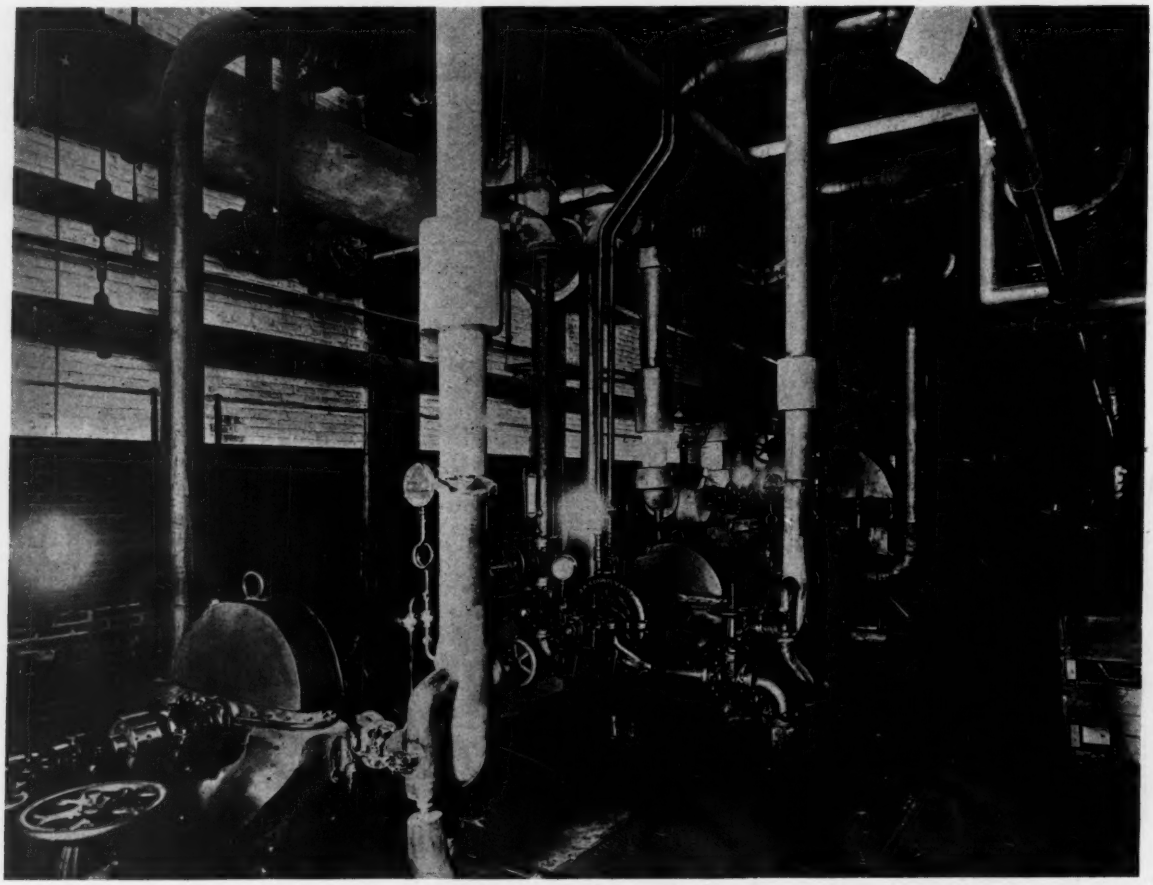


FIG. 7. PUMP INSTALLATION

variable speed transmissions on the stoker drive, thus regulating the speed of the stoker drive shaft. This increases the coal feed as the air chamber pressure increases, and that pressure is increased as the forced draft

Stacks are of the self-supporting steel type, 15 ft. 4 in. inside diameter, and have a height of 250 ft. above the grates. They have a 4-in. radial stack brick lining, with from 1 to 2 in. of grout between the brick and the

shell. The weight is carried on radial I-beam girders, with the base of the stack at the economizer floor level 60 ft. above datum, one stack being used to serve 4 boilers.

Feed Water

The main source of feed water supply is the condensation from the turbine units, which is returned through a 10-in. pipe to 2 storage metering tanks located above the heaters in the boiler house. The secondary source is the drains, drips and fresh water from the roofs, which is collected in a concrete storage tank below the ground floor of the boiler house and is fed by the service pumps into a makeup tank located at the same level as the main storage tank. When these sources are not sufficient, makeup water may be taken direct from the city mains at 50 lb. pressure. The main metering tanks are provided with Cochrane V-notch recorders, having a capacity of 4,000,000 lb. per hour each. The makeup tank has a Cochrane meter with capacity of 200,000 lb. per hour, and the inlet to this tank is controlled by 2 floats, the upper one controlling the inlet of water from the service pump which lifts water from the basement storage, and the lower float controlling the inlet of water from the city mains.

From the metering tanks, the water drops by gravity to an open storage tank of 76,700 lb. capacity, thence to the Cochrane open heaters located on the boiler floor level, of which 2 are installed, each having a 10,000 hp. rating and a capacity of 500,000 lb. of water per hour. These heaters are of horizontal type, elliptical in shape, 6 ft. 6 in. wide, 9 ft. 1 in. high and 20 ft. long. The boiler feed pumps located in the basement take their supply from the heaters by gravity and force direct to the boiler feed header or through the economizers to the boiler feed header, the rate of feed being controlled by Copes feed water regulators located on the mezzanine floor level and maintaining the level in the boiler constant by means of Foster reducing valves. Steam for the heaters comes from the auxiliary exhaust main, which takes the steam from the pumps and other auxiliary apparatus. All valves on the feed system are extra heavy cast steel, with Monel metal trim, furnished by the Pittsburgh Valve, Foundry & Construction Co. Controlling the supply of water to each boiler is a Schutte & Koerting check valve, a Hancock globe valve and an Edward drum head stop and check valve, the inlet line for each boiler being 3-in. pipe. Arrangement of connections is shown in Fig. 8. Blowoff is through an Everlasting and a B. & W. valve in series for each boiler, the water going to a metering tank equipped with a Cochrane V-notch meter of 300,000 lb. an hour capacity.

Pump Equipment

Two boiler feed pumps are installed and a third will be added when the boiler installation now being erected is completed. These were furnished by the International Steam Pump Co., Jeanesville Iron Works division, and are 3-stage, double-suction turbine pumps, with a 6-in. inlet and outlet, having a capacity of 1000 gal. per minute each, at 700 ft. total dynamic head, with an excess pressure regulator. They are driven direct connected through a flexible coupling by Westinghouse 250-hp. turbines at 2200 r.p.m., the turbines being designed to take steam at 190 lb. pressure and 150 deg. superheat, and operating noncondensing. Relief valves on the boiler feed pump are set for a lower pressure than those on the economizers in order to spare the relief valves on the economizers and to avoid the overflow of water in the upper stories of the boiler house.

A fire pump, supplied by the Lea-Courtenay Co., has a capacity of 1000 gal. per minute, at 110 ft. head, and is of the 2-stage type, driven by a Westinghouse 100-hp. constant speed motor. This pump may discharge either fresh or salt water to the fire system, which has outlets in the buildings and yard. It can also be used in emergency in place of the service pumps.

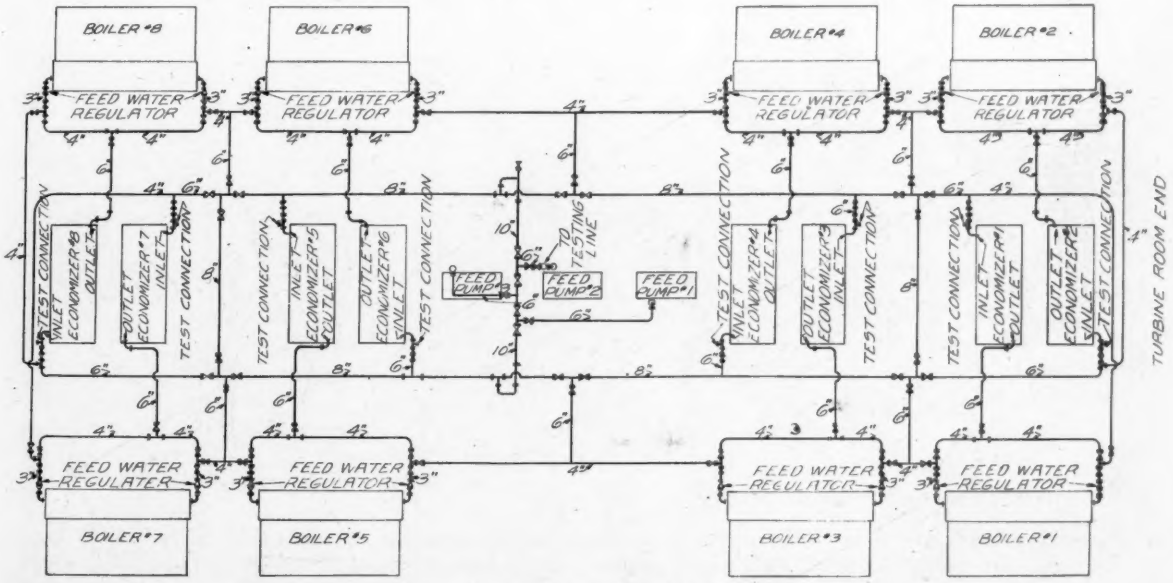


FIG. 8. DIAGRAM OF FEED PIPING

These service pumps are 2 in number, single-stage centrifugals, of 500 gal. per minute capacity each, at 110 ft. head, supplied by the Lea-Courtenay Co., and driven direct by Westinghouse noncondensing, 22-hp. horizontal turbines. The illustration Fig. 7 shows the 2 boiler feed pumps, one of the service pumps, and the turbine for the other service pump, and indicates, also, the arrangement of the steam and exhaust piping for these pumps. The arrangement of the piping is also indicated on the sectional drawing of the boiler house, Fig. 5.

Test System

In connection with the water handling system, a test system is provided by means of which any turbine or boiler may be tested for performance during its regular operation in service. When testing a turbine, the condensate is discharged to weighing tanks on platform scales located on the metering tank floor. From these tanks condensate is pumped to the metering tank by the service pump. For testing boilers, water may be taken from the metering tank to the weighing tanks, and then discharged through one of the feed pumps direct to the boiler feed header or to the economizer. The diagram of test piping, Fig. 9, shows the connections which may be made and the arrangement for using either No. 2 feed pump or the fire pump for transferring water when testing. A third arrangement when testing the boilers provides for feeding city water direct to the weighing tanks, if it is desired to use this line for boiler feed.

To make sure that there shall be no leakage when making tests, two valves are provided on the outlets and inlets of the No. 2 feed pump and the fire pump, with an open drip controlled by a small gate valve located between the two valves, so that any leakage either way through the closed valves can be immediately detected. There is a like double valve provision on the connections to the metering tank and to the feed water header from lines which may be used during testing.

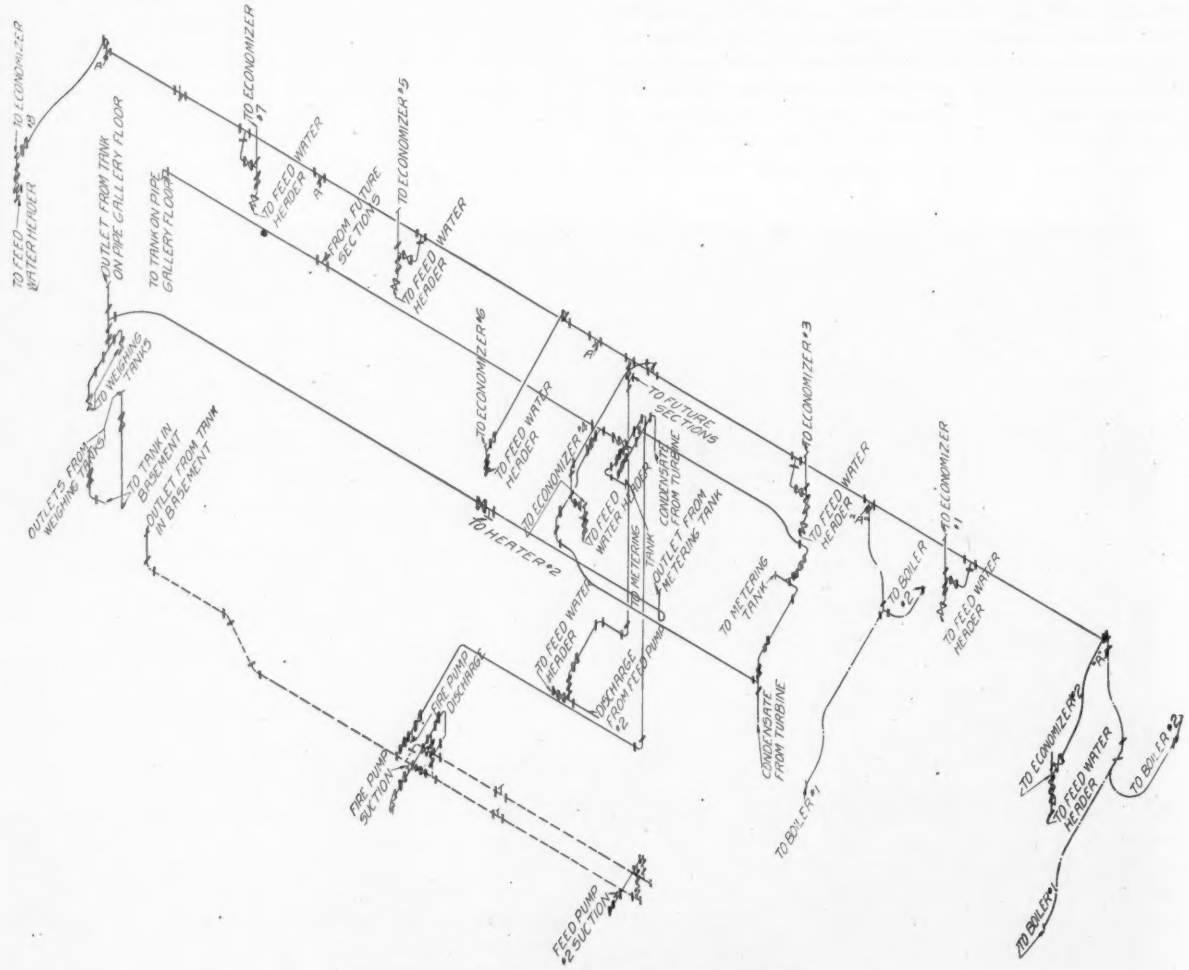


FIG. 9. DIAGRAM OF TEST CONNECTIONS

Economizers

For each boiler an economizer is installed on the upper floor of the boiler house, these economizers being of semi-steel tube type, furnished by the B. F. Sturtevant Co., and having the feed water heated by the multipass arrangement. The groups of pipes are 3 in number, placed in series. All sections are 12 pipes wide, the first group being 16 tubes long, and the second and third groups 12 tubes long each. Feed water is ad-

(Continued on page 795.)

Engine Governors--II

SHAFT GOVERNORS, PRINCIPLES AND CONSTRUCTION. BY E. C. WELLS

OF THE different types of shaft governors connected to a positive valve gear, the Straight-line, or Sweets patent, Fig. 5, is one of the oldest types. It consists of a single weight carried on one end of an arm, which is pivoted in the middle to one of the arms of the flywheel. A metal strap connects one side of the arm to the end of a flat steel spring, while the other side is linked to the eccentric in such a way that when the weight travels away from the shaft, which it does as the speed of the engine increases, the eccentric is shifted, altering both the eccentricity and the angle of advance, and thus regulates the cutoff to suit the load of the engine. The governor is adjusted by altering the weight of the ball, which is hollow and weighted with lead shot. This governor belongs to the centrifugal type.

In the inertia governor, the effect of inertia instead of acting as a disturbing force, is made to assist the weights in adjusting themselves to changes in speed. Figure 6 shows the type of inertia governor used on the McEwen engine and will serve to illustrate the principles involved in all governors of this class.

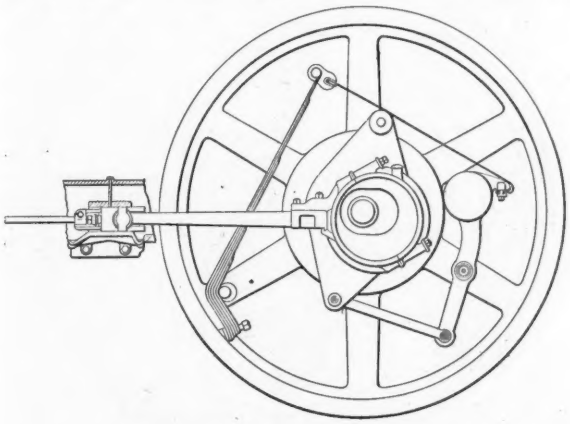


FIG. 5. SWEET SHAFT GOVERNOR

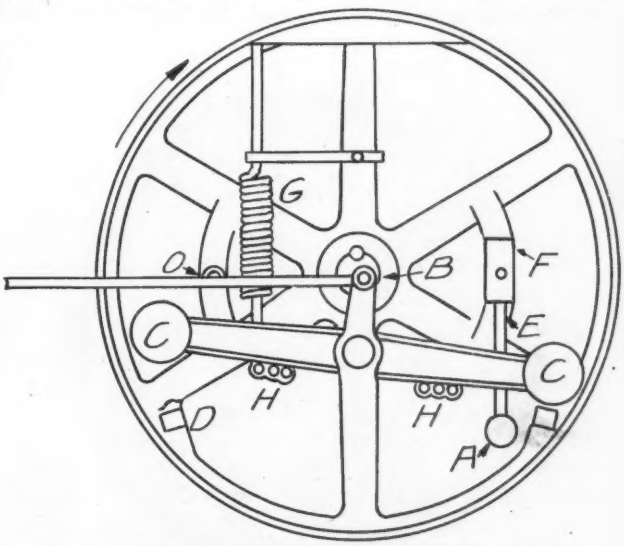


FIG. 6. INERTIA GOVERNOR USED ON MC EWEN ENGINES

The entire governing mechanism consists of a pivoted inertia bar, a spring, and an air dashpot. Referring to the figure, C C is the inertia bar, which is pivoted upon a roller pin-bearing. The inertia bar is symmetrical, with its 2 ends hollow. The end of the bar, to which spring G is attached, is weighted, and the motion of the bar is limited by the stops, D. F is the air dashpot, which consists simply of a cylinder with a loose-fitting piston and a connecting rod E, which is bolted to the inertia bar. A pin, B, is attached to an arm of the inertia bar, so as to swing across the end of the engine shaft, and the path of motion of this pin is a small circle, which varies in radius with the position of the inertia bar. This pin takes the place of the ordinary eccentric and operates the eccentric rod.

The action of the governor is as follows: Owing to the shape and relation of the various parts, the weighted end is acted on by centrifugal force, tending to swing it backward toward stop D, at the left-hand side of the figure. This tendency to move backward is counterbalanced by the spring, G, whose tension is such as to hold the inertia bar in equilibrium at the required speed. When the engine is starting up, the position of the governor parts is as shown. In this position the pin B travels in its greatest path, giving the valve its widest opening and latest cutoff. As the speed increases, the centrifugal force, acting on the weighted arm of the inertia bar, moves it backward toward left-hand bar stop D, thereby reducing the travel of the valve and cutting off steam earlier.

When a load is thrown on the engine suddenly, there is an immediate check to the speed of rotation of the governor wheel, while the inertia bar, by reason of its momentum, rotates forward sufficiently to increase the travel of the valve and give late enough cutoff to carry the load. The position of rest of the inertia bar depends upon the equilibrium of the centrifugal force and spring G, so that it can be seen that the speed of rotation under any steady running load depends upon this equilibrium, while the actual movement of the governor parts is affected by the inertia of the weighted parts. In other words, the actual work of governing is done by inertia, while the duty of the centrifugal force is simply to define the speed at which the engine is to run.

Dashpot F checks the motion of the bar and prevents too rapid changes in the eccentric position. The centrifugal force of the dashpot piston is counterbalanced by the weight, A, on the other end of the piston rod. The lug, H, to which the spring is attached, has 3 holes, by means of which the lever arm at which the pull of the spring acts, can be changed. A similar lug provides a means of attaching the spring to the opposite end of the bar, and the dashpot may likewise be shifted to lug O. In this way the direction of rotation may readily be reversed.

The Fitchburg governor, Fig. 7, belongs to that class which combines the centrifugal and inertia feature. In this governor the large weights are thrown outward by the centrifugal force and their movement is restrained by coiled springs, the smaller weights being affected in a tangential direction by their own inertia. The engine is governed at any stated speed by the large weights, but any small fluctuation in speed affects the inertia weights, which in turn operate the valve, causing the engine almost instantaneously to resume its normal speed.

The action of the governor is as follows: As long as the engine is below speed, the eccentric is kept in its longest throw by the tension of the springs and steam follows about ¾ of the stroke; but as soon as the proper speed is reached, centrifugal action causes the weights, H, to overcome the tension of the springs and to move outward, at the same time lengthening the springs. By means of the connecting rods, G, G, the outward motion of the weights turns the suspension arms, C, upon their fulcra, and through the ears, B, the eccentric is carried across the shaft, and as the arcs described by the centers B, B are in opposite curves, they compensate each other, and the center of the eccentric follows a straight line in its movement, preserving a constant lead opening. This decreases the eccentricity, and increases the advance of the eccentric, giving an earlier cutoff to the valve until, when the eccentric is swung squarely back of the crank, the valve opens only the lead, as there are all points between this and extreme cutoff for variation. Upon the least diminution of speed the springs have more power than the centrifugal force of the weights, and the motion of the parts is arrested and turned in the opposite direction, giving a later cutoff, as more work is performed by the engine.

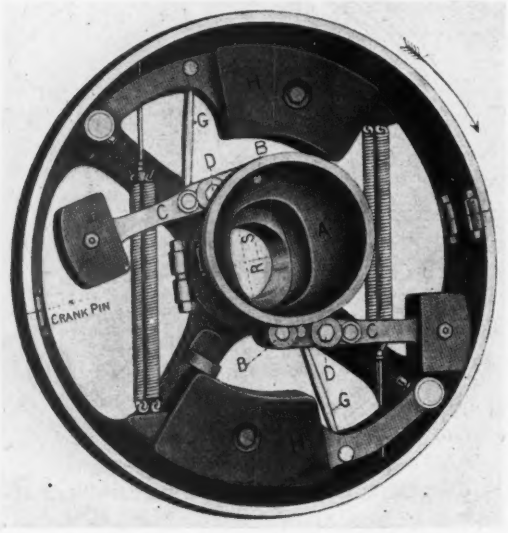


FIG. 7. FITCHBURG GOVERNOR

In some forms of governors the lead remains constant when the load changes, while in others the lead either increases or decreases as the load on the engine varies. If the angle of advance only is varied with an engine having a single valve, the cutoff is changed and the lead is changed, sometimes in a manner that is not desirable. If the eccentricity is changed, leaving the angle of advance unchanged, the same trouble is experienced, but in the opposite direction. That is, when the angle of advance only is changed, decreased cutoff means more lead. When the eccentricity only is changed, increased cutoff means more lead. A combination of these two should give a variable cutoff with constant lead. Upon examining the condition which is necessary to produce constant lead, it is found that the point of the valve rod must move in a straight line.

Figure 8 illustrates the Armington-Sims governor. As represented in the figure, the weights, A, A, are in the starting position. As the speed is increased, the weights are thrown outward by the centrifugal force, the effect of which is to roll the inner eccentric in one direction, and outer the opposite direction. By this means the eccentricity, represented by R in the figure, is reduced, the travel of the valve is shortened and the angle of advance is increased. The result of decreasing the valve travel and of increasing the angular advance is to make the cutoff earlier and increase the amount of compression; in other words, the work done by steam is less. As the speed decreases, the weights move back toward their original positions, the radius of eccentricity becomes greater, and the angle of advance decreases, consequently cutoff takes place later and the work of the steam is increased. The speed of the engine may be changed by tightening or loosening the nuts at the ends of the springs.

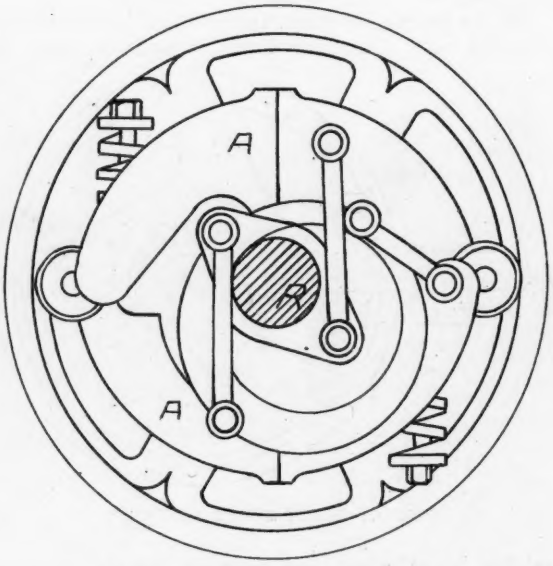


FIG. 8. ARMINGTON SIMS GOVERNOR

The Buckeye engine governor illustrated in Fig. 9 is one of the oldest forms of shaft governors. This governor differs from those described above in that the angle of advance only is varied by the centrifugal action of the weights, this being all that is necessary, as in this engine 2 valves are used, a main valve actuated by a fixed eccentric and a cutoff valve actuated by the governor mechanism. In the case of a single valve operated by a shaft governor, as before stated, if the angle

of advance only is altered, the cutoff may be varied to suit the conditions of load, but in that case the lead will also vary in such a way that it will increase as the cutoff is decreased. If, on the other hand, the regulation is performed by varying the eccentricity alone, the reverse would take place, and hence for shaft regulation in connection with a single valve it becomes necessary to vary the eccentricity and angle of advance simultaneously. This is not the case where a separate distribution and expansion valve are used, as in the Buckeye engine, because the admission and exhaust closure are effected by the distribution valve, and the governor acts only on the cutoff.

Referring to Fig. 9, it will be seen that the governor consists of 2 weighted arms, A, A, pivoted at one end to the wheel and connected at the other to the ears of a loose eccentric, C, by means of links B, B. The tendency of the arms to move outward by virtue of their

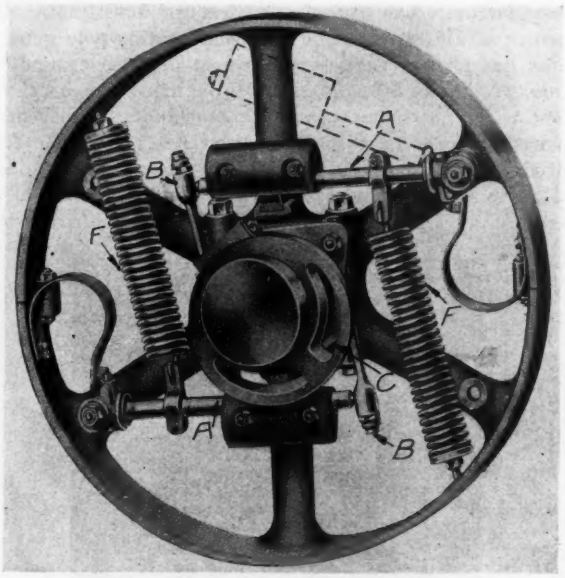


FIG. 9. BUCKEYE ENGINE GOVERNOR

centrifugal force is resisted by the action of the spiral springs, F, F. As the speed increases, the centrifugal force of the weights partially overcomes the pull of the springs, and the eccentric is advanced, allowing the cutoff to take place earlier.

The Westinghouse governor, Fig. 10, is another centrifugal form of governor. The two weights, B, B, are pivoted, to be capable of movement in radial lines outward from the shaft. These are held in equilibrium by the heavy springs, D, D, which tend to hold them up against the shaft, S. As the engine increases in speed, the weights move outward, due to the centrifugal force, and the weights move links E, E and F. These links shift the position of eccentric C, the arm of which is pivoted at A, producing the required motion of the valve. As the eccentric is drawn across the shaft to the left, its center is brought nearer to and farther around the center of the shaft, thereby decreasing the valve travel and at the same time increasing the angular advance. This increase in angular advance with the shorter valve travel gives an earlier cutoff without altering the point of admission. The governor is enclosed in a case, which is filled with oil, the eccentric alone, being

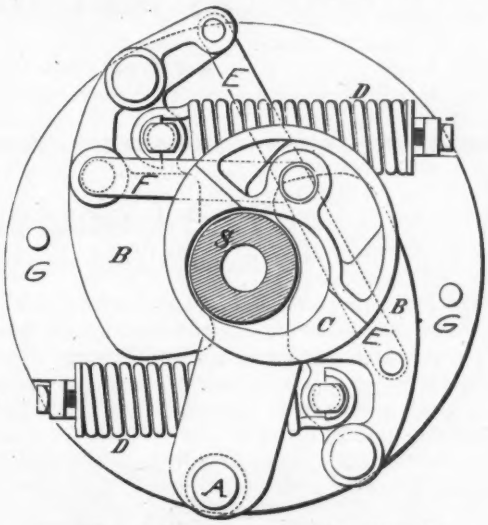


FIG. 10. WESTINGHOUSE SHAFT GOVERNOR

outside of the governor case, being carried on a shaft running through a sleeve, and bearing against stops when at full throw. The face of the eccentric is a segment of a sphere, to which the eccentric strap is scraped.

NEW DEVELOPMENT in constructive work is being brought out by The Society for Electrical Development, consisting of a series of 20 newspaper advertisements which has been prepared and mailed to jobber and contractor members for use in their local newspapers in assisting them in building good will by pointing out the benefits of dealing with recognized contractors. The advertisements, with complete directions for the printer, have been mailed so that the members will not be troubled with the detail of writing and laying out copy. Each advertisement emphasizes the fact that price alone should not govern the letting of contracts for electrical work. The service is free to Society members.

Time was when the electrical contractor carried his office and kit with him from place to place. Now there are contractors in each locality doing business on a reasonable basis and at prices based on known costs of construction. These men carry stocks of goods, know the requirements of various jobs, do their work carefully, according to specifications and the requirements of the insurance companies. Their prices are based on known conditions and the figures named permit of a reasonable profit that will permit carrying on business and development on a sound basis.

The Society for Electrical Development, 29 West 39th St., New York City, has prepared, also, as a help to these contractors, a slip to be attached to bids or tentative specifications, telling why the lowest bidder may not be the best one to have the contract. Both of these sales helps should be found of material assistance to the sound, reliable contractor.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

The Compensated Generator

ITS GENERAL CHARACTERISTICS AND ADAPTABILITY. BY DAVID HALL

HEAVY peak loads, high speeds and difficult operating conditions for direct-current machines necessitate the neutralizing of the distorting effects of the currents in the armature winding in order to secure good performance characteristics. The method of obtaining this result is to slot the pole faces of the field cores and place a winding in these slots which is connected in series with the armature. The number of

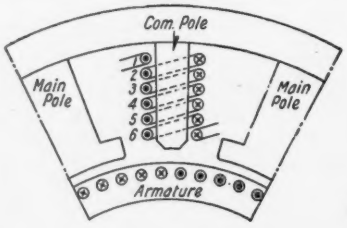


FIG. 1. MAIN AND COMMUTATING POLE OF A COMMUTATING POLE MACHINE

conductors in the pole faces is proportioned so as to neutralize the armature conductors covered by the pole face. The excess winding necessary to produce a commutating flux is concentrated on the commutating poles, located midway between the main poles.

Such a machine is known as compensated machine because of the special compensating or balancing pole face winding, the function of which is to compensate

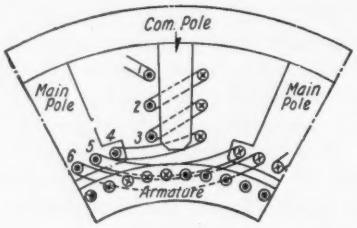


FIG. 2. MAIN AND COMMUTATING POLE OF A COMPENSATED MACHINE

for or balance the armature reaction, or in other words, to neutralize the magnetizing effect of the armature winding. It is therefore placed as near to the armature winding as possible, and the more uniformly this winding is distributed about the periphery or space surrounding the armature the more perfectly will its chief function be performed.

Generally speaking, direct-current generators and motors may be classified under 3 main heads, referring to their commutation characteristics: 1—non-commutating pole; 2—commutating pole; 3—compensated. All 3 types have a similar armature, shunt and series field construction. The commutation features constitute their principal difference. The non-commutating-pole generator has no provision for a flux to produce commutation, except as brought about by shifting the brushes. But with the commutating-pole machine and the compensated machine special provision has been made for producing a commutating flux. In these 2 cases additional poles are placed between the main poles, which are smaller than the main poles and are magnetized by

FIG. 3. MAGNETIZING CONDUCTORS EMBEDDED IN MAIN POLE FACE OF COMPENSATED GENERATOR

conductors which are connected in series with the armature, so that the magnetizing effect is proportional to the armature current.

The principal feature distinguishing the commutating-pole machine from the compensating machine is the winding of the conductors which neutralize the armature reaction and magnetize the commutating pole. With the commutating-pole machine all the conductors are wound around the commutating poles, as shown in Fig. 1. With the compensating machine some of the conductors are located on the commutating poles, while the rest are distributed in the main pole faces, Fig. 2, where they can more completely neutralize the effect of the armature magnetization and prevent the distortion of the flux under the main pole.

In large current machines this winding usually consists of a number of copper bars embedded in slots in the main pole faces and lying parallel to the armature conductors. As can be seen in Figs. 3 and 4, these bars are connected in series and in series with the armature, so that any change in armature current involves a corresponding change in the current on the compensating winding.

To secure a clear understanding of the benefits of a compensating winding it is necessary to know how the voltage is distributed about a commutator and how the maximum voltage between 2 adjacent commutator bars is affected by the armature reaction and how this maximum voltage is affected by the compensating winding, since the maximum voltage between commutator bars is one of the limiting features of direct-current machines.

If, for example, the voltage between 2 adjacent commutator bars becomes excessive, an arc may be established between them, and this arc may give rise to a flashover. Flashing between brushes or other mechanical parts consists in the formation of an electric arc, similar to the arc formed in an arc lamp. It takes a high voltage to form an arc through air, and therefore in an arc lamp it is found necessary first to bring the carbons into contact with each other, and subsequently draw them apart. After the arc has once been established a comparatively small voltage will maintain it, because the metal and carbon vapors between the electrodes are much better conductors than air. Hence the first means to avoid the formation of an arc at the brushes is the improvement of commutation, and the introduction of commutating poles and compensated windings has helped materially in eliminating sparking and consequent flashing. The minimum voltage which will cause flashing depends on several factors, hence there is no fixed value which can be stated as a limit for all machines. At the same time, any element which inherently increases this voltage is undesirable, and any means of neutralizing this effect without otherwise impairing the usefulness of the machine is desirable. Hence the introduction of the compensated-wound machines is another stage of the evolution of direct-current design. Such machines may be made to meet unusually severe requirements.

FIG. 4. STRAP CONDUCTORS ABOUT COMMUTATING POLE AND DISTRIBUTED IN MAIN POLE FACE OF COMPENSATED GENERATOR

The armature reaction has a quite different effect in each of the 3 types of machines. In the non-commutating-pole machine, armature reaction distorts both the main flux and the commutating flux; in the commutating-pole machine it distorts only the main flux, and in the compensated machine it distorts neither. The resultant effects of these distortions produce in the machines certain characteristics which determine their suitability to perform different classes of work. The commutating flux, or flux between the main poles, determines to a large degree the operation at the brushes, while the main flux under the main poles determines the voltage characteristics and also the voltage between adjacent commutator bars, which may have much to do with the operation under heavy loads.

As the commutating flux for the non-commutating-pole machine must come from the main poles, and as this flux does not increase as the load increases, it follows that it is necessary to shift the brushes with the load if the best results for commutation are obtained. Hence flashing may be experienced if the brush shifting is not affected.

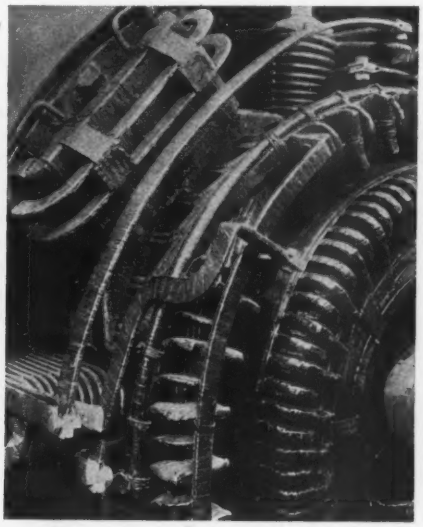


FIG. 5. COMMUTATING POLE WINDINGS AND CODUCTORS DISTRIBUTED IN MAIN POLE FACE OF COMPENSATED GENERATOR

Brush shifting is not necessary on either the commutating-pole machine or the compensated machine, since a flux for commutation is produced by the commutating poles midway between the main poles, which varies automatically and directly as the load, because the same current passes through the armature and the commutating-pole windings. The fact that non-commutating-pole generators require that the brushes be shifted, while the second and third class do not require any shifting, constitutes a difference in armature reaction, because with the brushes in the neutral position the reaction from the armature tends to establish a field which would pass through zero at the middle of the main pole piece and be a maximum between the main poles,

tending only to distort the main flux. However, the armature reaction in non-commutating-pole machines with the brushes shifted has 2 effects, one tending to distort the main flux, which is a cross-magnetizing effect, and the other directly opposing the main flux, which is a demagnetizing effect, and is proportional to the amount of shift of the brushes.

By fixing the brushes so that the coil under commutation lies midway between the main poles, which is the proper position in both commutating-pole and compensated machines, the demagnetizing effect of the armature is avoided, and on account of the absence of the demagnetizing effect of the armature such machines require less compounding. Hence the armature reaction in a commutating-pole machine has a cross-magnetizing effect, but not a demagnetizing effect. The cross-magnetizing effect tends to distort the flux under the main pole, the most serious effect of which is to increase the maximum voltage between commutator bars. This effect may be of serious consequence if the average voltage between commutator bars is already high.

The main benefits of the compensated winding are that it prevents, under sudden changes of load, the main flux from sweeping across the pole face; in other words, prevents a distortion of the main flux, thus lowering the maximum voltage which would otherwise obtain between adjacent commutator bars. Furthermore, it decreases the amount of leakage which is present when all the windings are concentrated on the commutating pole. It is evident that the leakage is very much reduced, when one considers that the leakage is mainly between the main pole tip and the commutating pole, and that the magnetomotive forces producing this leakage are much less because a large proportion of the conductors are located in the main pole face. For all these reasons, heavy overloads such as are found in roll-mill service, can be carried most satisfactorily on the compensated generator. The superiority of this type of machine is especially noticeable in the case of high-speed motor-generators and machines for roll-mill and hoist service, particularly when both generators and motors are subjected to high peak loads. Such loads are usually of short duration and consequently do not generate much heat in the windings, but the commutating conditions are exceedingly severe.—The Electric Journal.

Testing Out 3-Way Switch Circuits

METHOD OF DISTINGUISHING VARIOUS LEADS GREAT AID TO WIREMAN. BY C. H. TRAPP

WHEN 3-way switch circuits are installed for independent control at 2 different points in the circuit, there are always 3 wires at each of the 2 switch outlets. One pair of wires in each outlet runs between switches, as shown in Fig. 1; these wires are designated as "switch travelers." The third wire, F_1, Fig. 2, in one of the switch outlets is connected to one, the positive, side of the branch feeding the 3-way circuit and is designated as the "switch feed" wire. The third wire, F_2, Fig. 2, in the other switch outlet, returns to the lamps and thence to the opposite or negative side of the feeding branch circuit. This wire between the lamps and the switch is sometimes loosely called a "feed" wire, but this terminology may be somewhat confusing, as it is properly a return wire, although, indirectly, it does feed the lamps through both of the 3-way switches. The wire connecting the lamps to the negative side of the branch circuit should really be termed the "lamp feed" wire, as contracted to the "switch feed" wire. However, for the sake of brevity and convenience, the third wire in each of the 3-way switch outlets is usually termed the "feed" inasmuch as it connects to the "feed" terminal of the switch. The feed wire at each 3-way switch outlet should be marked for identification when testing out and connecting up for service, either by knotting it, nicking the insulation, or baring the end of the wire. If the

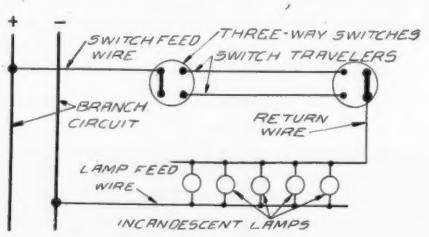


FIG. 1. THREE-WAY SWITCH CIRCUIT TERMINOLOGY

end of the wire is bared, this will, of course, save time when testing out. It is unnecessary to mark either of the traveler wires as it is immaterial in what position relative to each other they are connected.

Assume that a 3-way switch circuit has been installed as in Fig. 2, and that feed wires, F_1 and F_2, at each switch outlet have been properly marked. The circuit may be tested out either with a bell-and-battery set or with a magneto, as at Fig. 3. While in this illustration

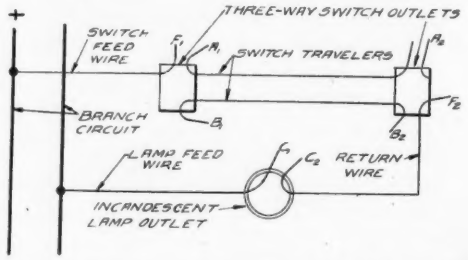


FIG. 2. THREE-WAY SWITCH CIRCUIT AFTER "ROUGHING IN"

the magneto is, for convenience, shown connected to the branch circuit taps, in practice it is usual to "ring out" a circuit from the distribution center. The object in testing out a circuit being to ascertain whether all of the wire runs are continuous and whether or not the connections to the branch circuit have been properly made, it is merely necessary to short-circuit wire ends F_1, A_1, B_1, as at X, Fig. 3, F_2, A_2, B_2, as at Y, and C_1, C_2, as at Z, and then ring out the circuit. If the magneto were connected at the points where the 3-way circuit taps the branch circuit, as shown in Fig. 3, the 3-way circuit would ring out O. K., even though both wires were connected to the same side of the branch circuit; however, since in actual practice the circuit would be

rung out from the distribution center, an off-circuit connection would be detected as soon as an attempt were made to get a ring.

While making the test just described, care must be taken not to destroy the identity of the feed wires. In case it is necessary to ascertain which are the feed wires and which the switch travelers, this can be done by ringing out and isolating wires A_1, A_2, and B_1, B_2, as at Fig. 4. The third wire at each of the outlets would, of

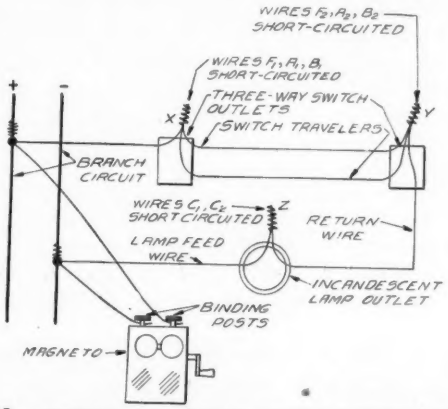


FIG. 3. TESTING OUT 3-WAY SWITCH CIRCUIT WITH MAGNETO

course, be the feed. Where the switch outlets are too far apart to allow ringing out of wires A_1, A_2, and B_1, B_2, in this manner, short-circuit wires F_1, A_1, B_1, Fig. 2, and test out successively any 2 of the 3 wires, F_2, A_2, B_2, at the opposite switch outlet until the magneto rings. The 2 wires on which the magneto rings will be the travelers. Now short-circuit these 2 traveler wires and test out successively any 2 of the 3 wires, F_1, A_1, B_1, at the first outlet until the magneto rings. This will indicate which are the travelers at the first outlet. The trav-

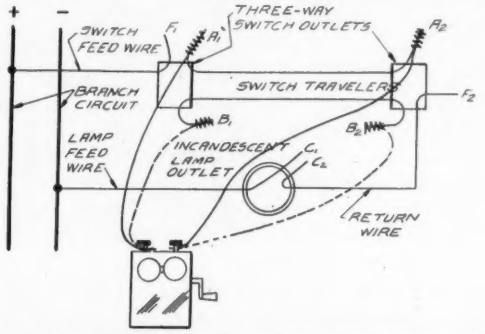


FIG. 4. LOCATING SWITCH TRAVELERS

elers are thus identified at each of the 2 switch outlets. While making this test, wires C_1, C_2 at the lamp outlet must not be connected.

To ring out the feed wires, short-circuit wires C_1, C_2, at the lamp outlet, Fig. 2, and after closing the branch circuit at the distribution cabinet, connect the magneto to wires F_1 and F_2. If the connections are O. K., the magneto will ring. If the magneto rings without closing the branch circuit, it is probable that the switch feed wire and the lamp feed wire are connected to the same side of the branch circuit.

Proposal to Rate Lamps in Lumens*

THE traditional basis of rating incandescent lamps is the mean horizontal candlepower. Successive experiences with carbon filament lamps, tantalum lamps and gas-filled tungsten lamps have shown this measure to be an inaccurate and inadequate index to the total illuminating power of a lamp. Such inaccuracy in the past had led to confusion and improper practice. During the past year or two this has become so pronounced in connection with gas-filled lamps that the mean horizontal candlepower has practically been abandoned as a basis of rating. As a substitute for the mean horizontal candlepower the mean spherical candlepower might be employed, as it is free from most of the objections which can be urged against the mean horizontal candlepower. A preferable unit, however, is the lumen, which is the unit of light flux. Roughly, the lumens of a tungsten vacuum lamp are about 10 times the mean horizontal candlepower. More accurately, the lumens are 12.57 times the mean spherical candlepower of a lamp. (12.57 will be recognized as the ratio between the area of a sphere and its radius, i.e., 4×3.1416). The lumen is a logical unit of light flux which is approved by scientific and engineering societies and by the best engineering opinion. It has the advantage that it is applicable in common to the light produced by a lamp and to the light delivered upon a plane which is illuminated. It forms the basis of a complete system which is now adopted generally in illuminating engineering practice.

It has been the practice to indicate the efficiency of incandescent lamps by a statement of the watts per candle. It has been definitely recognized that this expression is the reciprocal of the efficiency and is nothing more than a statement of the specific consumption of a lamp. Nevertheless it has been referred to loosely as the "efficiency." When lamps are rated in lumens a natural and proper expression of the efficiency is the lumens per watt. When the efficiency of lamps is increased the lumens per watt properly are increased. This straightening out of our nomenclature is an incidental but important advantage which the rating of lamps in lumens will make available.

The integrating sphere photometer which is now perfected and largely used by testing laboratories and manufacturers in the photometry of lamps makes it entirely practicable to rate lamps in lumens. This apparatus is rapidly supplanting the older style photometers with which the mean horizontal candlepower was measured. Engineering opinion, as represented by the official pronouncements of the Illuminating Engineering Society, American Institute of Electrical Engineers and by our own Committee on Electrical Measurements, Values and Terminology, is unanimously in favor of the new method. The lamp manufacturers have abandoned the old method as the basis of rating of all Mazda lamps; the Standard Specifications for Incandescent Lamps employ the former method only as an indication of the total light produced, which latter is adopted as the basis of comparison and is now obsolete in testing laboratory practice.

*National Electric Light Association—1915 Report of Committee on Terminology, also in 1916 report.

Why the Diesel Went Out

CAUSE OF A WRECK AND SEVERAL BREAKS, THE WHY AND THE REPAIRS. BY JOHN PIERCE

A FEW days ago I started out on my vacation and to see what I could see. Also, I took my faithful "Kodak" along, and as a result I am sending a few details of a Diesel engine wreck and some pictures of it. This wreck took place some 18 months ago, and so, while the story is old and it is now impossible to get the best of pictures, it may be of interest to the "boys" to know how nobly the factory responded in the matter.

At 8 p. m., while the load was at its peak at this station, which is situated in Oklahoma, the night man was back of the engine putting in water which goes into the crank case every 4 hr. The chief engineer had just come in and was at his desk near the switchboard some 60 ft. from the Diesel. Suddenly, without any warning, there was a loud crash and in the twinkling of an eye the engine had stopped and the lights were out. Pieces of the end door castings which had broken out were still flying. The men quickly secured lights and, having just reflued a boiler which they had at the time under pressure for testing, were fortunate enough to be able to start the steam plant and furnish current for the business section within a few moments.

FIG. 1. SOME BEARINGS AND A SHAFT END

FIG. 2. MORE BEARINGS AND ANOTHER SHAFT END

Investigation showed them a badly battered oil engine and a broken crank shaft. The shaft was raised from its main bearings, having broken the caps and torn loose the bearings themselves. The cam shaft was badly bent, as were the 3 connecting rods. The outboard bearing was torn loose and the base plate, 4 in. thick, was broken in a dozen places. A monstrous flange coupling connecting the engine to the generator was broken in several pieces, which saved the generator from destruction. On the other end of the shaft, the coupling direct connecting to the air compressor with flexible connection was sprung out of shape and crank shaft and connecting rod of the compressor were bent badly, while the compressor crank shaft bearings were broken. Pistons striking the heads cracked 2 heads badly.

The manufacturing firm was wired by 9 p.m., and at midnight its superintendent of construction left St. Louis. Upon arriving, he at once wired the company for new parts, and they dismantled a new engine of that type and shipped the parts within 48 hr. after the wreck had occurred; also by the time these parts were at hand, the best erecting man was on the job, and did a No. 1 job of quick repair. After the engine was in operation and time for settlement came, the Power Co. asked for a statement, which was sent them marked "$2500 PAID." This is where I thought the "boys" might find the interesting point.

This 'Paid" business. Other companies might make good, but we *know* this one did. And the reason for it was that though the engine was guaranteed for defects for one year, and had run nearly 3 yr., yet there was a flaw in the crank shaft which had been there from the time of making, and the Busch-Sulzer-Diesel Engine Co. felt that though it had not been discovered in the first year, yet being there all the time made them liable. In taking the accompanying pictures, I also ran across the one which shows the old cylinder heads stacked up back of the building. One of these was cracked by the cooling water having been stopped and then cold water turned in. Two were cracked by the wreck, and the other one met its end in a peculiar way.

In the center of the pistons is an eye bolt hole. The clearance is ⅛ in., and with a slight deposit of carbon not quite that. Number 3 cylinder seemed to have a slight knock in it, pounding badly at the heaviest load and not at all on the lightest.

At this plant the engineer prefers his crank and crosshead brasses a trifle slack rather than a burned bearing, and since their ordinary "runs" are of 16 weeks' duration without a stop, once having made 19 weeks at one run, I think his plan a good one, inasmuch as one can't be exactly certain how high his oil and water are in the crank case. At one point of the cycle of each cylinder there are 25 in. on rim of flywheel where atmospheric pressure only is in the cylinder. At that exact point the knock took place. The engineer thought that his bearings were getting a little too slack, since he had been on a continual run of 12 weeks, and that the sudden release of what compression there was in the cylinder allowed the piston to pitch upward, striking the head. So he shut down and took up lost motion and

started up. But that night the load, coming to peak, found it knocking as badly as ever. Next day another stop was made and clearance taken.

This was done with a twist of lead wire. Clearance was found to be exactly ⅛ in., or just right. Then he decided that it must be something that he had not yet found in his limited experience as a Diesel operator, and decided to write the Diesel people's chief engineer, Max

FIG. 3. REMAINS OF THE CRANKS

Rotter. So he started up again, and that night, while peak was at its highest and knock was very pronounced, the head suddenly split clear across and flooded everything. Now, mind you, the knock sounded all this time as if it was in either the crank or the main bearings.

A new head was wired for, came by express, and the engine was in service inside of 48 hr. after the accident. But on taking off the old head it was discovered that the heat had caused the rim of the eye bolt hole to rise up, and the greater the load, the more heat, and the higher

FIG. 4. CRACKED HEADS FROM THE BATTLE FIELD

this bulge would rise, each time settling or contracting, as load went off, less than the previous time, consequently getting higher all the time. The entire bulge was of 6 in. diameter, coming to a point at center. In placing the lead wire in the cylinder for clearance it was laid to one side of the center and, of course, showed correct clearance.

This bulge was chiseled off and brought back to a level with the planed surface of the balance of the piston, and since that time there has been no trouble from that source. The engineer states that notwithstanding these various incidents, all are well pleased with the engine, and they contemplate an additional installation within the present year.

Relative Steam Velocities

Convenient Charts for Proportioning Engine Piping and Ports

AMONG the problems frequently met in power plant design and operation is the proper proportioning of steam and exhaust pipes, and ports to the engine which they serve. While the problem is not difficult, mathematically, those who are not making similar calculations frequently may be confused for a time in working out the problems. For convenience in checking up work and selecting pipe sizes 2 calculating charts are given in the Practical Reference Tables of this issue which are sufficiently accurate for the purpose and will solve problems more rapidly than by ordinary calculation.

The chart showing relation of piston speed to steam velocities in pipe can be used most frequently for calculating pipe sizes or steam velocity through the pipe. Consider first that you know the piston speed in feet per minute, the diameter of the pipe and the diameter of the cylinder, and you wish to find the velocity of steam in the pipe. In this case you start at the left hand side of the chart at the number representing the piston speed, trace horizontally to the right until you meet the diagonal whose number represents the diameter of the steam pipe, then trace vertically to the diagonal whose number represents cylinder diameter, then trace horizontally to the right and read the steam velocity on the right-hand scale. The course is shown by arrows on the chart.

To get proper pipe sizes you determine first the steam velocity most desirable, then trace from the right-hand scale to the left until you meet the diagonal representing cylinder diameter, then vertically until you meet the horizontal line representing piston speed as indicated by the scale to the left. The point of intersection will be on or near a diagonal line representing the proper pipe diameter.

For checking up or designing port openings, the chart showing the relation of port area to piston area and steam velocity is of value. Having given the area of the port or any opening through which steam must pass to or from the engine cylinder, the area of the piston and the piston speed in feet per minute, to find the steam velocity through the port, start with the area of port opening on the scale to the left, trace horizontally to the right until you meet the diagonal line representing the area of the piston, the ratio of port opening to piston area will be found directly below this intersection on the scale at the bottom of the chart. The point of intersection of the vertical line representing ratio of areas with the horizontal representing piston speed, as noted in the scale to the right, represents the steam velocity through port, as noted on the lower diagonal scale. This problem is outlined by arrows on the chart.

U. S. Civil Service Commission announces an examination, Sept. 19, for mechanical draftsman, Ordnance Department at Large, to fill 2 vacancies in the position of skilled draftsman, experienced in the design of telescopic instruments, at $1320, in the Frankford Arsenal, War Department, Philadelphia, Pa. Apply for Form 1312.

Fifteen Thousand Horsepower Vertical Turbines

By Frank C. Perkins

THE accompanying illustration shows one of the largest vertical hydraulic turbines designed at York, Pa. This is one of 6 units recently developed for the Great Falls Power Co., at Great Falls, Mont. Each of these units under 150 ft. head develops 15,000 hp. on the turbine shaft, which is a single runner unit mounted in a cast-iron scroll case.

It may be stated that the intake end of the scroll shown in the photograph is 8 ft. diameter. In addition to these 6 main units there are being installed 2 similar types of units of 850 hp. each, which drive the exciters. This power is used for the electrification of the Chicago, Milwaukee & St. Paul R. R., where they are electrifying something over 400 miles of road through the mountains.

FIFTEEN THOUSAND HORSEPOWER VERTICAL TURBINE FOR DRIVING ELECTRIC GENERATOR AT GREAT FALLS, MONT.

In another power development, the wicket gate turbine is mounted in a cast-iron spiral flume and direct-connected to a vertical generator. The upper section of the draft tube is steel, and the balance concrete. A hydraulic gate valve, relief valve and governor are provided and the thrust bearing is mounted on top of the generator.

In this plant 5 units, each of 17,000 hp., operating at 514 r.p.m. under 600-ft. head, were designed and built for the Georgia Power Co., and installed in its Tallulah Falls Plant. There are 6 vertical shaft Francis turbines in pressure flumes driving generators in the Roosevelt plant of the U. S. Government, Salt River, Ariz., the capacity being 9000 hp. at 400 r.p.m. with a 226-ft. head.

In one installation, the wicket gate turbine is arranged with a concrete shaft tube and for direct connection to a vertical generator and the thrust bearing for carrying the weight and thrust of the runner, also, the weight of the rotor of the generator is placed on top of the generator instead of on a separate floor. By removing the rotor of the generator, the turbine can be removed.

In some instances, the wicket gate turbine is mounted in a concrete spiral flume and direct-connected to a vertical generator. The draft tube is of concrete and flaring cast-iron flanges with guide blades are imbedded in the concrete and act as a part of the concrete spiral flume. The top plate of the turbine is provided with a bearing and packing box. The thrust bearing is mounted on top of the generator.

A Napier's Formula Chart

By N. G. Near

IN the Practical Reference Tables is given a chart based on Napier's formula:

$$W = \frac{pa}{70}$$

where W = weight of steam flowing through the orifice per second. The chart, however, gives the flow per minute instead of per second, in which case Napier's results are multiplied by 60;

p = steam pressure in lb. per sq. in. absolute;

a = area of orifice in sq. in.

To determine the flow, just stretch a thread across the chart from given point to given point, and the problem is solved. Or, lay a straight edge across. Anything straight will do the trick.

For example, the thread stretched across the chart shows one solution. Where the steam pressure is 100 lb. absolute, and the area of the orifice is 0.5 sq. in., 43 lb. of steam will flow through the orifice every minute. The digit "three" in the 43 must be estimated with the eye, but it can be done very closely.

Napier's formula is used a great deal because it is strikingly accurate for cases where steam flows directly into the atmosphere, as in the case of soot blowers, blowers for inducing draft in boilers, etc. Where there is a back pressure in addition to atmospheric back pressure, it is not so accurate and should then be replaced by other formulas.

The chart can be used "backward" as well as forward, where it is desired to determine the necessary orifice area to care for a certain weight of steam, as in the case of safety valves (in connection with which a factor of safety must be used), or, the pressure necessary to blow out a certain weight of steam can be determined.

As will be noted, the range of the chart is very wide.

Doubling the width of a single belt gives you more horsepower capacity than using a double belt of the same width, and the cost of double thick belt is just as much as that of the double width belt.—The Gas Engine.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Wrecking Porcupine Boilers

A SHORT TIME ago, the writer was employed at a plant where they had 2 500-hp. and 3 250-hp. Porcupine or Hazelton water-tube boilers. The firm decided to take out the 3 small boilers and put in larger ones. To do this, we first took the stacks down as shown in Fig. 1. We took 2 timbers 6 by 6 in. 16 ft. long, ran a 1-in. rod through and put a 1¼-in. pipe over it, as shown. Then we ran ⅝-in. guy wires from the top of these timbers to the edge of the roof. A set of chain falls was used to raise the stacks after it was cut at the edge of the roof. The stack was raised a little and the bottom of stack was pulled out with a set of rope falls, and then the chain falls were let out, and the stack was lowered. Next the hood, Fig. 1, was cut off, and let down inside the building.

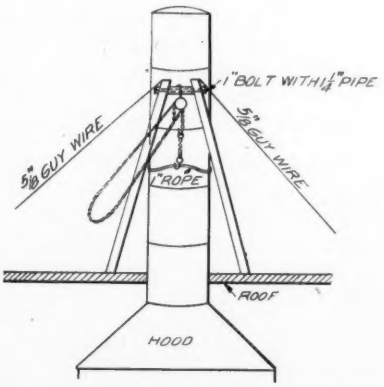


FIG. 1. METHOD OF TAKING DOWN STACK

Then we rigged up our falls as shown in Fig. 2. A timber was put across the hole in the roof where the stack went through, and chain falls were fastened to this. A set of 1-in. rope falls was fastened to the chain falls. We did this because our rope falls would not reach the bottom tubes, and by putting the chain falls in the place shown, we could reach the lower tubes by lengthening the chain falls. We had a coal hoist and carrier with an overhead track, placed a 6 by 6-in. timber between track and floor and fastened a snatch block to the lower end for the cable of the hoist to run on. Then we fastened rope falls to cable as shown. To do away with slack in the cable when the motor on the hoist was reversed, we attached a weight at A. Another weight was attached at B to assist the man in pulling back the falls so as to put loop in chain, over the end of tube. A rope was run from the top of the boiler to the shifter on the coal hoist. The man working the shifter could see when the loop in the chain was placed over the tube and start the motor and pull out the tube.

With this arrangement, and 3 men, we were able to pull, on an average, 4 tubes a minute. The brick work around the boiler was taken down gradually as we pulled the tubes, to give the men a place to stand on, so they

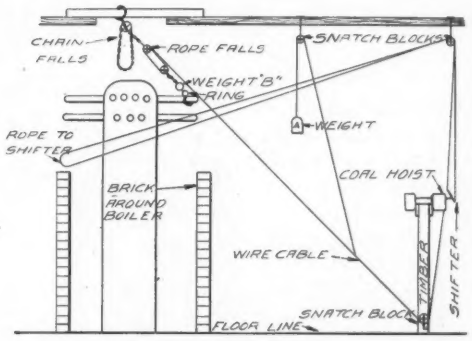


FIG. 2. REMOVING TUBES FROM PORCUPINE BOILER

could reach the tubes. After pulling the tubes, the boiler was raised with chain falls hitched to the top of shell and a timber across the stack hole. Then the bottom of the boiler was pulled out and the chain falls slacked off gradually as the bottom was pulled out. A. WILLIAMS.

Sectional Ashpit Increases Efficiency

UPON STARTING to work in a new plant, the method of firing employed struck me as exceedingly inefficient. We had 600-hp. B. & W. boilers with hand-fired stationary grates, superheaters and economizers, and employ forced draft. Air was forced into the ashpits through the bridge walls, also by wing blowers in the sidewalls. Each furnace has 3 firing doors, and it was the custom of the firemen when cleaning fires to pull 2 sections at a time, which resulted in a drop of steam pressure from 10 to 25 lb. The firemen are foreign laborers, who stay with us but a few days or weeks, and to train them properly is impossible, so we seemed to be compelled to put up with inefficient firing.

After a study of the situation, one of the company's engineers, Mr. Andrews, suggested a change in the ashpit construction which has proved a wonderful success. We divided the ashpit into 3 parts with metal partitions running longitudinally under the grates; the wing blowers were removed and to each section of the ashpit an opening was made from the draft chamber in the bridgewall; one of the blowers, however, was put in the air flue to help out the fan engine.

When the fire is cleaned, one section is cleaned at a time. The section to be cleaned is allowed to burn nearly

to ashes, the forced draft damper under this section is closed and the damper in the breeching is partly closed. When this section becomes dead, the ashes are pulled and live coals winged over from a neighboring section, green coal is sprinkled over the section, dampers are opened and the fire is in good condition very quickly. This method prevents the inrush of cold air during cleaning period and, by working the other sections a little harder, the drop in steam pressure is unnoticeable. As a result of this construction, the coal consumption has been reduced, accumulation of ash and formation of big clinkers have been minimized, heavy barring eliminated, and the expense of replacing firebrick lining has been reduced.

B. C. WHITE.

What Ailed the Pump?

ONE of our pumps for no apparent reason began to slow down one day, although both the steam and water pressures were normal. Nobody paid very much attention, however, except to open up the throttle valve a little more, so as to bring it up to speed.

The next day the same thing happened, so the throttle valve was opened some more. Toward evening the pump began slowing down again and the throttle opened still more. By this time we had come to the conclusion that something was wrong with the pump, but as it could not be spared it was left to run that way. It kept on going from bad to worse until finally it would just drag along with the throttle valve wide open.

Something had to be done, so we shut it down one evening and went through it. We could not find anything wrong.

The steam valves were perfect and showed they had had plenty of oil, as also did the cylinder. Steam pistons and piston rings were in first-class condition and worked freely and easily.

None of the stuffing-boxes were tight. The water ends were examined and found in first-class condition. After we had looked it all over, we got a bar and worked it back and forth several times and found it worked easily. When we started up again, it went fine for a few strokes and then it began to slow down until, finally, with the throttle wide open, it barely moved. While we were debating what to do next, the gasket blew out on the low-pressure steam chest cover.

We got this replaced, and when we started we had the same performance over again; that is, the pump started up rapidly at first and finally barely moved along.

While we were figuring on where to start in next, the gasket in the flange connecting the exhaust pipe to the pump blew out. We replaced this on short notice, and when starting up again the pump acted the same way as it did before.

I began to suspect that the valve in the exhaust line, where it connected to the main exhaust header, was shut, or nearly so, and I sent one of the men up to investigate. It was wide open.

Still I was not satisfied that everything was as it should be, so I obtained a gage and connected it to the drip line from the exhaust pipe and started the pump up again. To our surprise, the pressure came up by leaps and bounds, until it was nearly as high as the steam pressure. Evidently the line was obstructed. We removed the bonnets from the stop valves in the exhaust line; there was one at the pump and another at the main header. Both were intact.

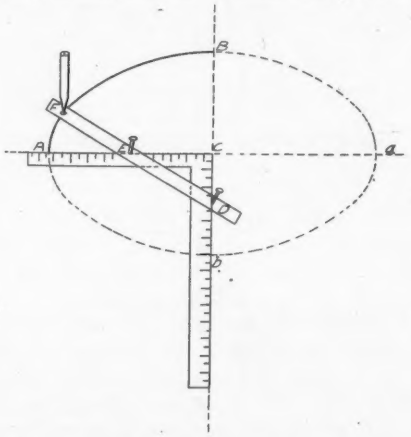
Finally, I had the men start the pump again, and by getting up on a ladder I went along the pipe, laying my ear up to it at intervals. The line was of considerable length, and when I had got some distance away from the pump, I could plainly hear the hissing sound of throttled steam. I got down and went to where the line connected to the main header, but everything was quiet here, so I followed the line back till it went through the wall and out on a roof, without finding anything, so I got up on the roof next. There I could plainly hear it. It was very dark up there and I could just see a dim outline of the pipe; but by feeling my way along, I finally came to a valve. It was practically shut. Connections had been made here for another pump which was out of service. There was practically no packing on the stem, which left it very loose, and the pulsations of the exhaust had rattled it shut. We reversed the valve, packed the stem and had no further trouble.

E. W. MILLER.

Method of Drawing an Ellipse

WITH all due respect to A. W. Schoof's method of drawing an ellipse, as described in the Aug. 1 issue, page 660, I wish to submit my method for the benefit of those readers who might be interested.

Instead of cutting a piece of wood to the required size and shape, tying a special pencil to it and cutting a wooden square, which will take some time to make a good job, I simply use a common square of any kind that I find handy, a small strip of thin wood (a cigar box is good), 2 small brads or nails and a pencil.



METHOD OF DRAWING AN ELLIPSE BY AID OF A TRY SQUARE, A STRIP OF WOOD, A PENCIL AND 2 BRADS

To draw an ellipse, lay out 2 lines at right angles to each other as A a and B b. Let A a represent the longitudinal axis and B b the transverse axis, both being the desired length; place the square so that the heel will rest at the intersection of the lines as at C.

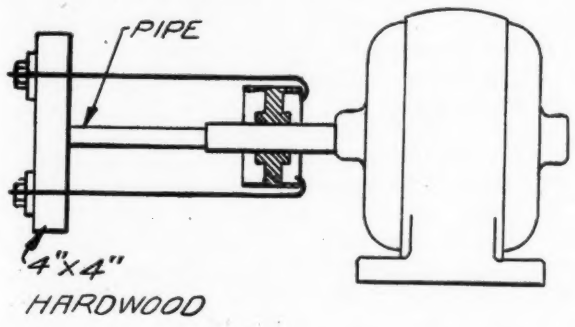
Take the strip of wood and mark off D, E and F—D E being half the transverse axis and D F half the longitudinal axis; drive the small nails in the strip at D and E. Make a small hole just large enough to admit the point of a pencil at F.

Now place the strip on the square as shown in the sketch and move point F from A to B, being sure to have points E and D bearing against the square at all times. This will describe ¼ of the ellipse; then, by reversing the square, the entire ellipse may be drawn.

This is a very simple method requiring few tools, and a little study of the sketch will make it clear to anyone having to draw an ellipse and not having an elliptical trammel at hand. H. E. NOTTHOFF.

Removing a Tight Pulley

REFERRING TO G. H. Brough's article on page 618, July 15 issue, under the caption, "Removing a Tight Pulley," suppose, for instance, he did not have any jack; in fact, he doesn't need one. He could have bored 2 holes in a 4 by 4-in. hardwood bar and threaded his hook bolts 2 or 3 in., put a washer on, and using a piece



HOOK BOLTS AND HARD WOOD YOKE USED TO REMOVE PULLEY

of pipe just a little smaller than the bore of the pulley, he could have tightened up with a wrench. If the pulley does not move when the nuts are pulled up tight, hit it a few blows with a heavy hammer. Of course, I would use a drift pin against the hub of the pulley if convenient. If not, hit the 4 by 4-in. hardwood bar that the hooks go through. I have removed pulleys in this manner that others had given up in despair.

FRED V. BROADAWAY.

Care for New Belts

BELTS, IN MANY respects, are like most other pieces of machinery. They "settle down" only after use. If well maintained they will run better the second year than the first.

Most belt troubles are caused by early neglect. The good that is in the belt is quickly lost unless some attempt is made to keep it there.

The best way to keep the good in the belt is to make the belt even more pliable than when new. Do not allow it to slip at any time, for slip generates heat and heating is hard on all belts—old as well as new. The belt becomes charred, hard, and can never be rejuvenated. The good is gone forever. Proper treatment when the belt is new is the only protection against this effect.

Again, if the belt is not treated when new and even if it does not slip, there is a certain amount of internal wear produced by one dry fiber sliding and grinding against the other, which leads to early self-destruction. If these fibers are lubricated when the belt is new, there can be no grinding and wearing out.

Of course, the belt must be treated from time to time thereafter just as any machine must be oiled from time to time, but a machine does not need as much oil after it has settled down as when new. The same is true of belts.

Get after your belts when new. N. G. NEAR.

Unaflow Engine Performance

IN PRACTICAL ENGINEER of July 15, discussing Newer Types of Steam Engines, on page 605, the statement is made that the Unaflow engine costs more per kilowatt installed than a Corliss engine. The writer does not agree with this unless the engine under discussion is a simple Corliss.

We have installed in our plant 2 Unaflow engines, one 33 by 36-in. at 125 r.p.m., driving an a.c. generator whose indicating wattmeter shows from 600 up to 900 kw. The other unit is 19 by 30 in., at 150 r.p.m., also driving an a.c. generator whose wattmeter indicates from 100 to 275 kw.

For the larger unit the cost per rated kilowatt was $16.66 exclusive of the piping and generator, and per average kw. carried the installation cost us $13.33. For the smaller unit the cost per rated kilowatt was $33.33, and per average kilowatt carried $25.

The writer had the first unaflow engine in operation in this country—a 33 by 36-in. unit, which is doing duty in our plant today and has given such good satisfaction that we bought a second one a year ago. This second unit has been in service 24 hr. a day, 7 days a week, since Aug. 16, 1915, and has given no trouble whatever. There was some trouble with the first unit which was due not to the principle of the engine, but to the design. The engine was rebuilt with the design changed, and is now entirely satisfactory, both units pulling overloads of 100 per cent. They operate condensing or noncondensing, changing over without noise and without any attention. The first engine was installed in 1912, and has done duty continuously, the rebuilding being done at such times as we had a chance to shut the plant down for a few days at a time. The steam pressure is 170 lb. vacuum running from 15 to 28 in. At 16 in. vacuum the larger unit develops 850 kw.

In regard to prices, when we installed these units we had bids from nearly every engine builder, and the prices for Corliss engines were about the same as, and in some cases even higher than those for the unaflow type; but even if they cost more in dollars per kilowatt, the saving in steam consumption after installation would pay for the difference in cost. A. C. RUHL.

A FIRM in Chile desires to enter into commercial relations with manufacturers and exporters of machinery and steel products, etc., used in connection with the nitrate-reduction industry, and other goods, such as iron and steel beams, plates, rails; machinery and automobiles and accessories; lubricants, oils, explosives, asbestos, paints, belting, cement, crucibles, cars, lumber, flour, salmon, lard, electrical material, pig iron, and white metals of all kinds. References are furnished to the U. S. Bureau of Commerce.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Coast Artillery Corps Examination

THE FOLLOWING questions submitted by O. S. Romans of Fort Caswell, N. C., are those asked in a recent examination for the position of Master Electrician in the United States Coast Artillery Corps.

1. (a) Define force and the work done by force. What are the units of work and force commonly used by engineers in this country?

(b) State difference between the gravitational and absolute units of force and work. Why are the latter so desirable for scientific purposes?

A. (a) Force may be briefly defined as a pull or a push. The product of the force times the distance through which it acts is called the work performed by that force.

Engineers generally express force in pounds and work in foot pounds.

(b) That force acting on a unit of mass giving it unit acceleration is called an absolute unit of force. When these units are the centimeter, the gram and the second, we have what is generally termed the C. G. S. system, the absolute unit of which is that force which will give to one gram an acceleration of one centimeter per second per second and is called the dyne.

In the gravitational unit account is taken of the acceleration due to gravity which is equal to 32.2 ft. per second per second. Instead of the unit of force as in the absolute system being equal to the product of the mass times acceleration, it is in the gravitational system equal to the product of the mass divided by 32.2 times the acceleration. The gravitational system using the weight of the pound as the unit of force is employed in most English speaking countries. The absolute system, however, bears the simplest possible relation to the units of mass, length and time.

When the dyne is taken as unit force and the centimeter as unit length, the unit of work is that performed by a dyne acting through a centimeter and is called an erg. As this unit is, however, very small, a multiple of it, namely, 10,000,000 ergs, is frequently employed and termed a joule.

When the weight of 1 lb. is taken as unit force and the foot as unit length, the unit of work is the work done by a force of 1 lb. acting through a distance of 1 ft. This unit is called the foot pound.

2. Sketch and describe some form of absorption friction dynamometer.

The pulley to which the brake of such a dynamometer is fitted is 3 ft. in diameter and makes 100 r.p.m. when the engine is at work. A weight of 200 lb. is registered on the scale, which is fixed 21 in. from the axis of the shaft.

What is the horsepower developed? Prove formula used.

A. One of the oldest and most generally employed types of friction dynamometer is the Prony brake. This, as shown in Fig. 1, is made up of brake beam BB, to one end of which is attached block BK, and adjustable strap ST lined with a series of maple or oak cleats. The opposite end of the beam is fitted with a knife edge which bears upon the top of pedestal P resting on the platform of scale S.

With the required tension placed on the straps and the desired weight upon the scale, the brake horsepower may be determined by dividing the product of 2 times 3.1416 times the length of the brake arm in feet times the number of revolutions of the pulley per minute times the weight indicated by the scale, by 33,000.

With the data given, the brake horsepower will in this case be equal to the product of, 2 times 3.1416 times 1¾ times 100 times 200, divided by 33,000, or 6.6 hp.

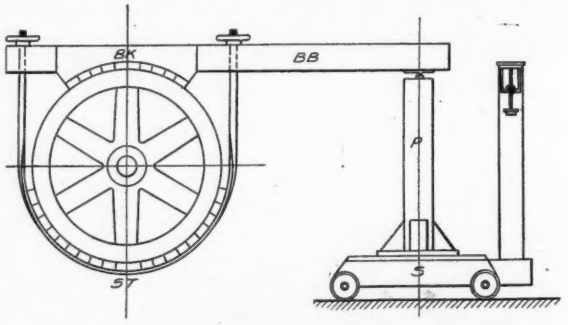


FIG. 1. GENERALLY EMPLOYED FORM OF FRICTION DYNAMOMETER, THE PRONY BRAKE

Work done in a given time in producing the friction (the power absorbed) is measured by the weight moved, or that indicated by the scale, multiplied by the distance it would pass through in that time if free to move. The weight is that registered by the scale and the distance it would pass through if free to move, is the circumference of the circle, the radius of which is equal to the distance from the center of the shaft to the knife edge at the end of the brake beam, expressed in feet. In other words, the power absorbed in foot pounds is equal to the product of 2 times 3.1416 times the number of revolutions per minute of the pulley, times the weight registered by the scale. Dividing this product by 33,000 will give the horsepower.

3. The travel of a planer table is 9 ft.; it makes 80 double strokes per hour, cutting both ways. Find the resistance to motion if there is 5 hp. actually expended in the machine.

A. Number of cutting strokes is equal to 2 times 80, or 160; the total cutting travel is, therefore, equal to 9 times 160, or 1440 ft. per hr., or 24 ft. per min.

As 1 hp. is equivalent to 33,000 ft. lb. per min., 5 hp. are equivalent to 5 times 33,000, or 165,000 ft. lb. per min. With travel of 24 ft. per min., the resistance to motion is equal to 165,000 divided by 24, or 6875 lb.

The actual cutting resistance is somewhat less than 6875 lb., as this also includes resistance offered by the machine parts.

Length of belt = L = 2(bc + arc ab + arc cd)

Draw ck parallel to oo' and produce bc to intersect ck.

ok is therefore equal to o'c = r, hence bk = R + r and ck = L_1

In right-angled triangle kbc we have

$$bc = \sqrt{\overline{ck}^2 - \overline{bk}^2} = \sqrt{L_1^2 - (R + r)^2}$$

Triangles obx and kbc are similar and angle bck = angle A. We therefore have sin angle bck = $\frac{bk}{kc}$, or sin angle = $\frac{R + r}{L_1}$

From the above figure we have arc ab = arc ax + arc xb =

$$\frac{2\pi R}{4} + 0.0175\ R \text{ angle A.}$$

Also arc cd = arc yd + arc yc = $\frac{2\pi r}{4}$ + 0.0175 r angle A.

Adding the values of bc, arc ab and arc cd, we obtain for the total length

$$L = 2\left[\sqrt{L_1^2 - (R+r)^2} + 1.57\ R + 0.0175\ R \text{ angle A} + 1.57\ r + 0.0175\ r \text{ angle A}\right], \text{ or}$$

$$L = 2\left[\sqrt{L^2 - (R+r)^2} + 1.57\ (R+r) + 0.0175 \text{ angle A } (R+r)\right]$$

Applying the data given we find

$$\sin A = \frac{R + r}{L_1} = \frac{1.5 + 1}{6} = \frac{2.5}{6} = 0.4166$$

Angle A is, therefore, equal to 24 deg. 37 min.

and $L = 2\left[\sqrt{6^2 - (1.5+1)^2} + 1.57\ (1.5+1) + 0.0175 \times 24\ \frac{37}{60}\ (1.5+1)\right]$

$= 2\left[\sqrt{36 - 6.25} + 1.57 \times 2.5 + 0.0175 \times 24\ \frac{37}{60} \times 2.5\right]$

$= 2\left[\ 25.75 + 3.925 + 1.076\right]$

$= 2 \times 10.40 = 20.80$ ft.

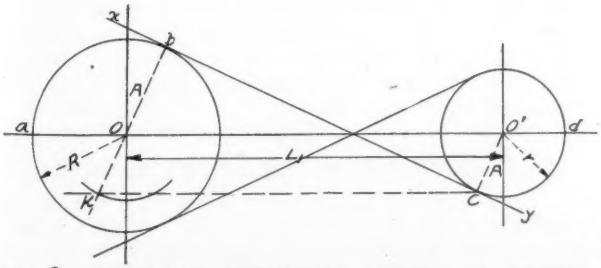


FIG. 2. METHOD OF DETERMINING LENGTH OF CROSSED BELTS AS EMPLOYED IN BELTS AND PULLEYS, BY CROMWELL

4. A lever safety valve has the following dimensions; area of valve 3.2 sq. in.; weight of valve and spindle 9 lb.; horizontal distance from fulcrum to center of valve, 3.4 in.; weight of lever, 3 lb.; distance from center of gravity of lever to fulcrum, 8 in. The movable weight is 67 lb.

What is the distance along the lever that the weight should be moved for a difference in pressure of 10 lb. per sq. in.?

A. From the data given, and assuming a steam pressure of 100 lb. per square inch, the total force tending to open the safety valve is equal to 100 times 3.2, or 320 lb. Acting at a distance of 3.4 in. from the fulcrum, the moment about this point is equal to 320 times 3.4, or 1088 lb. Opposing this are the moments of 9 times 3.4, or 30.6, 3 times 8, or 24, and 67 times X, the distance between the fulcrum and movable weight. Adding these moments we have 54.6 + 67 X.

In order just to prevent the valve from opening, it will be necessary to place the 67 lb. weight at a distance of X in. from the fulcrum. The value of X may be obtained by dividing the difference between 1088 and 54.6, by 67, which gives us 15.4 in.

With the steam pressure increased to 110 lb., the total pressure acting upward against the seat is equal to 110 times 3.2, or 352 lb.; at a distance of 3.4 in. this results in a turning moment of 1196.8. X in this instance is equal to (1196.8 — 54.6) divided by 67, or 17 in. It will, therefore, be necessary when increasing the steam pressure from 100 to 110 lb. to shift the weight, 17 minus 15.4 in., or 1.6 in., toward the end of the lever.

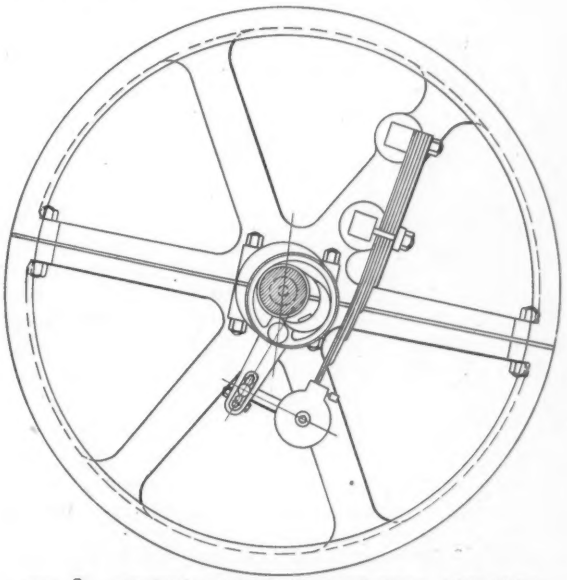


FIG. 3. GENERAL FORM OF CENTRIFUGAL GOVERNOR

5. A shaft making 100 r.p.m. carries a driving pulley 3 ft. in diameter and communicates motion by means of a crossed belt to a parallel shaft at a distance of 6 ft. carrying a pulley 2 ft. in diameter.

Allowing a slip of 1½ per cent, determine the speed of the driven shaft.

Find the speed of the belt and by the aid of a geometrical construction determine its length.

A. The product of the speed in revolutions per minute times the diameter of the driving pulley is equal to the product of the speed in revolutions per minute times the diameter of the driven pulley. We, therefore, have the speed of the driven, or 2-ft., pulley equal to the quotient obtained by dividing the product of 3 times 100, or 300, by 2, giving us 150 r.p.m. Correcting for the 1½ per cent slip, we have an actual speed of 147¾ r.p.m.

The circumference of the driver is equal to 3 times 3.1416, or 9.4248 ft. As its speed is 100 r.p.m., any point on its circumference travels at the rate of 942.48

ft. per min., which, neglecting slip, is also the speed of the belt. See Fig. 2 for solution for determining length of belt.

6. What is the essential difference between an inertia and a centrifugal governor? Give sketches of each kind.

A. In Figs. 3 and 4 are shown sketches of centrifugal and inertia governors respectively.

In the first-mentioned illustration, the governor weight is so suspended by means of a leaf spring that it moves approximately in a radial direction due to the action of centrifugal force. The action or movement of the weight is by means of a short link communicated to an arm attached to the eccentric so that, with an increase of speed, the weight tending to fly outwards shifts the eccentric so as to cause the steam to be cut off earlier, thus reducing the speed to normal.

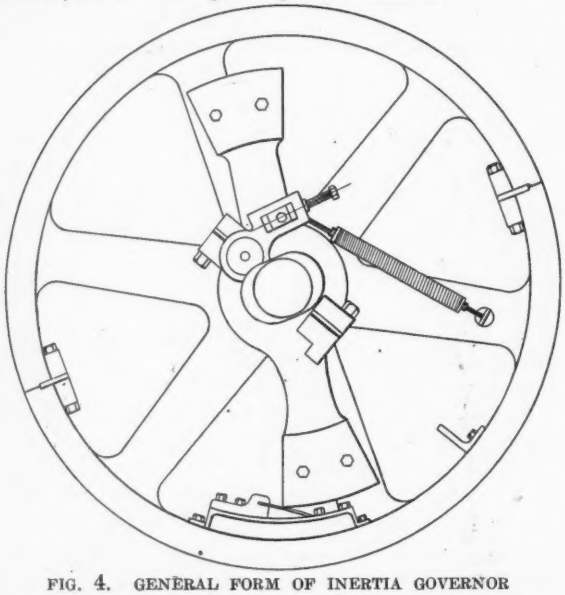


FIG. 4. GENERAL FORM OF INERTIA GOVERNOR

With a speed less than normal, the weight due to the action of the spring moves inward and places the eccentric so that the valve will be caused to admit more steam to the cylinder and thereby cause the engine speed to increase.

In the inertia type of governor, a combination of centrifugal force and inertia is employed. The 2 governor weights are fastened to a single arm which rotates about a pin. One weight has a larger arm than the other and is the dominating weight. As the engine revolves, this weight tends to assume a radial position, which gives the governor its initial position and determines the position of the valve.

With an increase of load, the engine will tend to slow down. Due, however, to the inertia of the governor weights tending to maintain their original speed, the eccentric will be so shifted as to cause the valve to open wider and admit more steam to the cylinder and allow the speed to reach its normal value. An increase of speed will, in a similar manner, cause the steam to be cut off earlier due to the lagging of the governor weights and accompanying shifting of the eccentric.

The travel of the governor weights is limited by the stops shown. (To be continued.)

True Boiler Horsepower

How many methods are there of calculating the horsepower of a boiler? Which is the correct method?

E. P.

A. The horsepower of a boiler is usually figured either from the amount of heating surface provided or from the amount of steam actually evaporated. In the one case it is known as the rated horsepower, and in the other case it is the horsepower delivered.

You should understand that boiler horsepower has no relation to engine horsepower at the present time. When the boiler horsepower rating was established in 1876, the steam supplied by a boiler horsepower was about sufficient to furnish an engine horsepower, with the engines in use at that time, but the improvement in steam engine design since that time has been such that a boiler horsepower may supply steam for 2 or even 3 indicated engine horsepower, with the best modern prime movers.

For the rated horsepower based on heating surface, usually 10 sq. ft. of heating surface are allowed per boiler horsepower for water-tube boilers, and 12 sq. ft. of heating surface for return-tubular boilers. The heating surface is figured as that surface which has water on one side and hot gases on the other, the surface considered being that in contact with the water.

For figuring the delivered horsepower, the amount of water evaporated must be known from test, also the conditions for feed water temperature and steam pressure. The actual evaporation is then reduced to equivalent evaporation from and at 212 deg. F., by multiplying the actual evaporation by the factor of evaporation.

The boiler horsepower is established by the A. S. M. E. Code for test as 34.5 lb. of water evaporated per hour from and at 212 deg. F. If you wish to go into this matter further, you should get from the American Society of Mechanical Engineers, Rules for Conducting Performance Tests on all kinds of Power Plant Apparatus. It can be had from the Society, 29 West 39th St., New York City. This gives full rules for the tests on all kinds of power plant apparatus, and is a valuable book to have in one's library. A. L. R.

Superiority of Pop Safety Valves

Why is a pop safety valve better than one of the ball-and-lever type?

2. Why does a pop safety valve "pop"?

G. F. B.

ANSWERS

The spring-loaded safety valve is superior to the lever safety valve because after it opens, the steam presses against a larger area than that exposed when the valve is closed. This causes the valve to lift higher, and retards the closing until the pressure has been reduced to a value slightly below that at which the valve opens. An additional advantage of the spring-loaded valve is that it may be locked and thus prevent any tampering with the adjustment.

2. As explained above, as soon as the pop valve is slightly opened, a larger area is exposed to the steam, and the sudden increase of pressure effective upon the valve bottom is the reason that the valve rises with a "pop." W. P.

Mechanical Equipment at Point-No-Point

(Continued from page 778)

mitted to the bottom of the economizer, passing upward in 8 sections of the first group, downward in 4 sections, and up in 4 sections. By a return bend, the water then passes to the bottom of the second group, rises in the first 4 sections, passes downward in the second 4 and upward in the second 4. It then returns to the bottom of the third group, and flows through this the same as through the second group, and then is discharged to the feed water header. Each economizer contains a total of 480 tubes, 12 ft. long, 4⅝ in. external diameter, giving 7750 sq. ft. of heating surface, which is 56 per cent of the heating surface of the boiler. Piping connections are provided so that the method of circulation in any group can be changed as desired.

Steam System

Entering the boiler as previously described, the feed water, after being converted into steam, passes to the horizontal cross drums and then through 2 8-in. discharge nozzles to pipe bends which carry the steam to

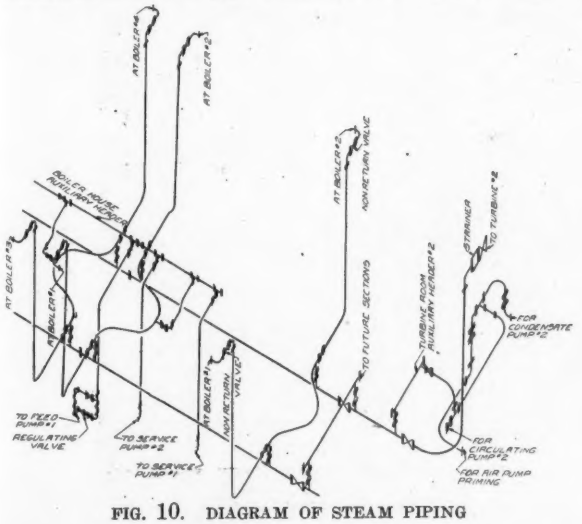


FIG. 10. DIAGRAM OF STEAM PIPING

the superheater header, Figs. 5 and 10. From the superheater, it passes through Edward stop and check valves to 8-in. mains, and downward to expansion cross bends which form a connection between boilers in opposite rows, this expansion cross connection being located in the top of the pump alley. From these cross connections, tee connections are taken to 2 high-pressure headers running lengthwise of the alley, which conduct the steam to the turbine house.

These long headers are anchored at the center, so that one-half of the expansion goes each way from that point, and at the turbine house end they are connected by expansion bends and risers through a strainer to the turbine inlets. An auxiliary high-pressure header for supplying steam to the turbines driving pumps is located in the pump alley, and is connected to the cross-connecting bends. Near the turbine house, there is a cross connection between the main headers which has a blank end for connection to future installations of boilers. There is, also, a tee connection from each high-pressure lengthwise header to a cross turbine room auxiliary header, from which the steam supply is taken for the condenser pumps.

Figure 10 shows the scheme of connections for the steam piping and the main connection to the No. 2 turbine, the connection to No. 1 turbine being the same but omitted for the sake of clearness in the diagram. The loop which rises to the turbine is anchored at the floor to avoid strain on the turbine connection, but the anchor is fitted with springs to permit of the rising of the turbine as it expands when heated. From the auxiliary turbine room header, connection is made by long bends to an auxiliary main which feeds to the circulating pump, the condensate pump, and supplies steam to an injector for priming the air pump. The connection diagram shows the piping for boilers Nos. 1, 2, part of 3 and 4, the No. 1 feed pump and the service pumps, connections to other boilers and feed pumps being identical.

The headers are carried on sling rods and cross beam suspensions with springs to allow for come and go. All piping is fitted with reinforced Van Stone joints, having asbestos gaskets, and with rolled steel flanges, the necks and nozzles being acetylene welded to the headers. All valves were furnished by the Pittsburgh Valve Foundry Const. Co.

Discharge from the safety valves is to a header which has an outlet to the roof, the header being well dripped to ensure the removal of all moisture. This roof discharge for one line of boilers is also connected downward, and acts as a steam vent for the open heaters.

Each set of 4 boilers supplies steam for a Curtis horizontal type turbine made by the General Electric Co., which drives a generator of 25,000 kv.a. capacity, or 20,000 kw., at 80 per cent power factor. The turbine is of 12-stage type, running at 1800 r.p.m., and weighs 325 tons. The over-all dimensions are 55 ft. 6 in. in length, 18 ft. 8 in. in width, and 13 ft. 4 in. in height. Eight stages are used for the high pressure steam and 4 stages for the low pressure, steam being supplied at 190 lb. boiler pressure and 175 deg. superheat maximum.

At each turbine is an auxiliary stop valve furnished by the Pittsburgh Valve Foundry & Const. Co., and a governor throttle supplied by Schutte & Koerting. The stop valves at the boilers, sectionalizing valves for the headers, and the turbine stop valves are motor driven.

All steam piping, except the rise and bend which connects to the steam turbine, is below the turbine floor level, this floor being raised somewhat above the level of the boiler floor.

Condenser Equipment

Turbines exhaust downward through an outlet 8 ft. 6 in. by 16 ft. directly to surface condensers. From the exhaust chamber, a 36-in. outboard exhaust is taken off, this line, which is of riveted pipe, being carried back into the boiler house and up through the roof. The condensers are of the 2-pass type, having 32,000 sq. ft. of cooling surface each, consisting of 6434 1-in. tubes of 18 B.W.G. Admiralty metal, the tubes being 19 ft. long. This gives 1.28 sq. ft. of surface per kilowatt, and provides for the condensation of 7.5 lb. of steam per square

foot of cooling surface per hour. Condensate at 80 deg. F. is taken from the condensers by an 8-in. Westinghouse centrifugal pump having a capacity of 500 gal. per minute, and is discharged under 19 lb. pressure to the metering tank already described, which has a capacity of 9200 gal. Expansion joints in this condensate line are provided of corrugated copper.

The condensing equipment was furnished by the Westinghouse Machine Co., of East Pittsburgh, Pa. The equipment includes: 2 32,000-sq. ft. surface condensers; 2 steam turbines with reduction gears, for circulating pump drive; 3 24,000-g.p.m. circulating pumps; one 60-cycle motor for circulating pump drive; 2 Westinghouse-LeBlanc air pumps; 2 60-cycle motors for air pump drive; 2 condensate pumps; 2 steam turbines for condensate pump drive; exhaust connections to turbine, and spring supports. An additional circulating pump was furnished later.

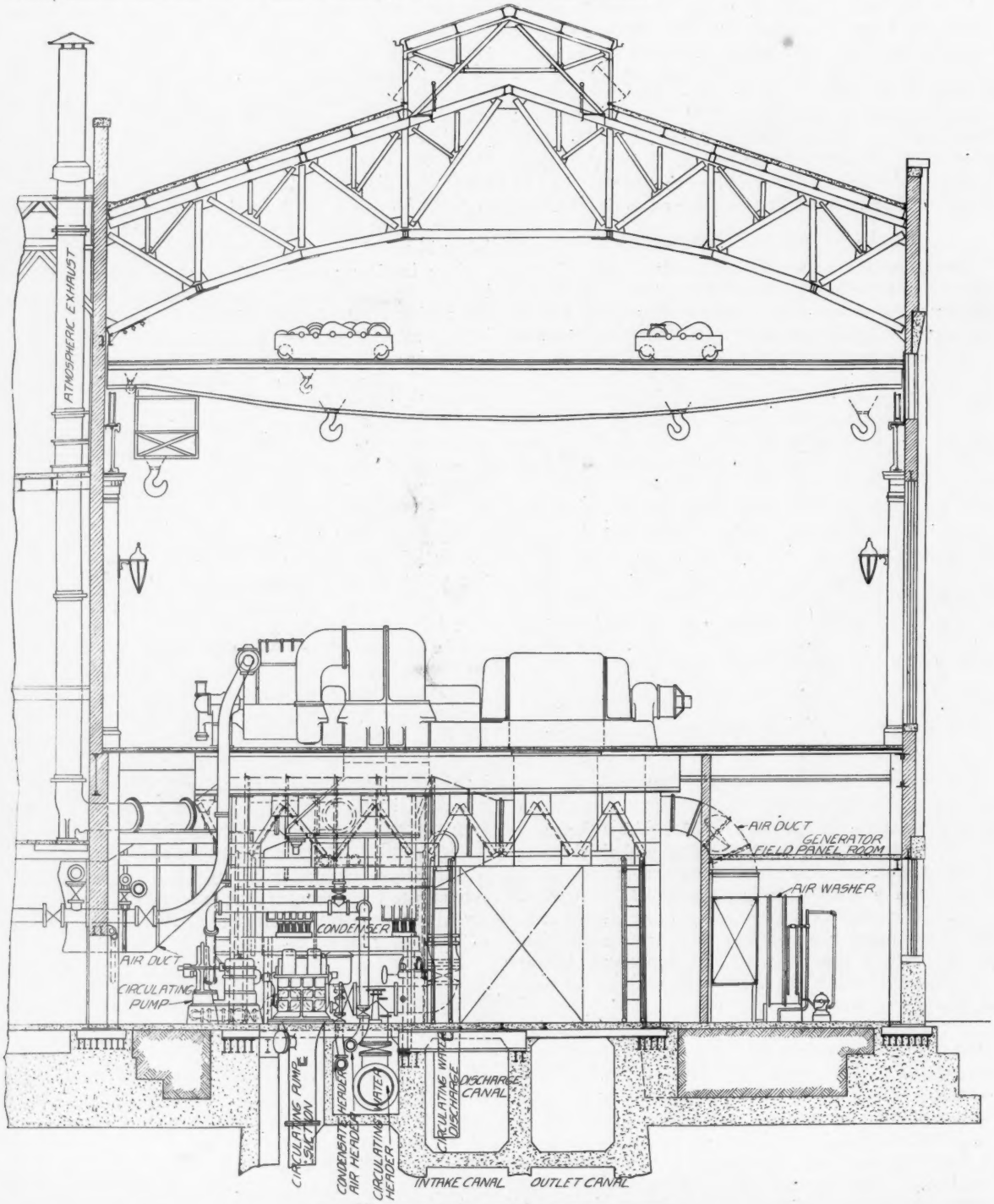


FIG. 12. SIDE SECTION OF TURBINE HOUSE

The surface condensers serve 2 25,000-kw., horizontal steam turbines, and are of the radial flow type. The radial flow design consists in arranging the tubes in a nest the center of which is eccentric with respect to the center of the shell, and locating the air off-take substantially in the center of the nest. This allows steam to enter the whole periphery in the nest, and the travel, of the condenser. This means that the lineal length of travel for the steam through the tubes is only about one-half of that required by the older type of condenser. All condensate in the radial flow design must fall through the surrounding envelope of live steam, and will, therefore, assume the temperature of the steam entering the condenser.

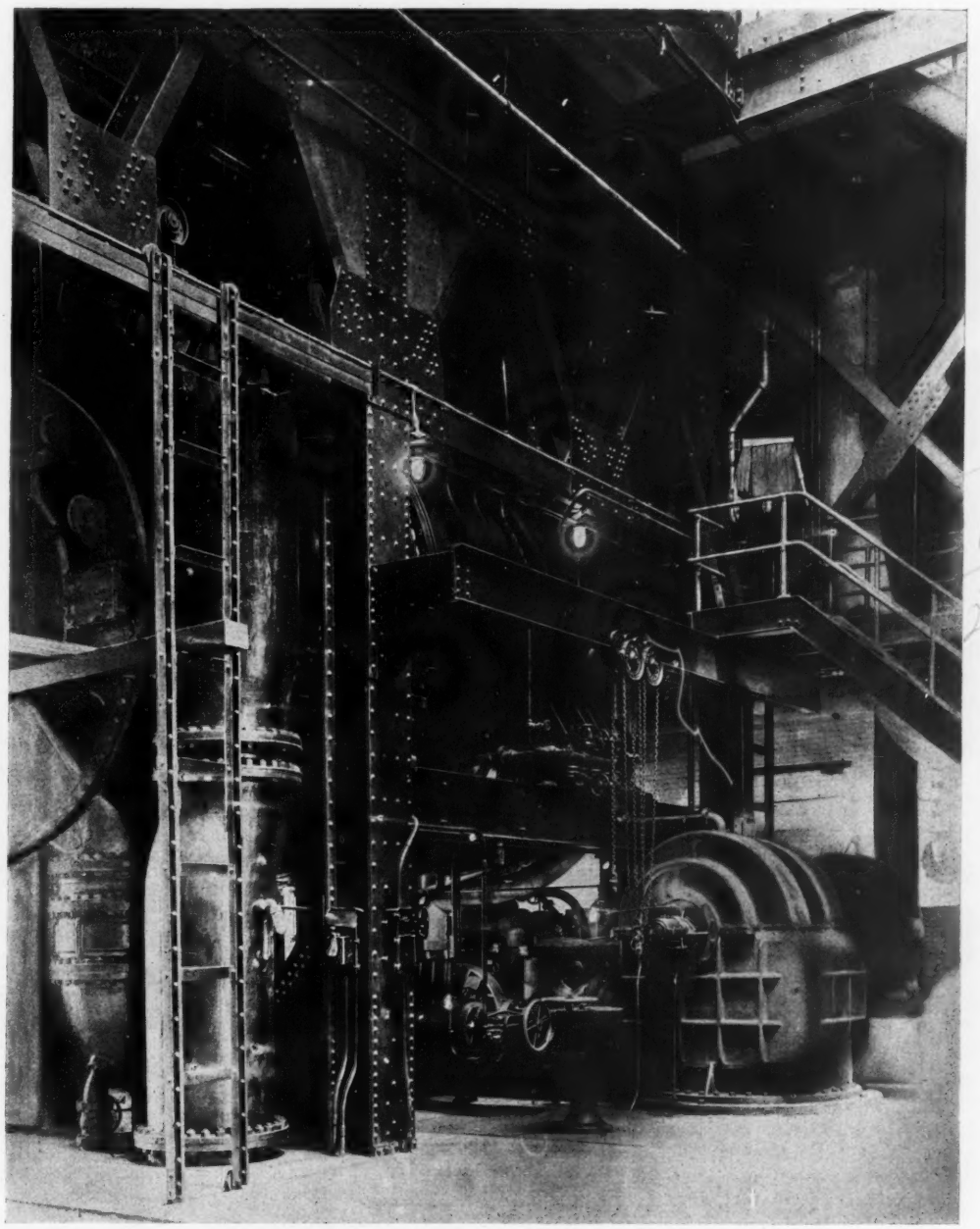


FIG. 13. MOTOR DRIVEN PUMP SIDE OF CONDENSER

lineally to the end of the condensing zone, is very short. In the radial flow arrangement, steam enters around the whole perimeter of the nest of tubes, giving practically double the area for the introduction of steam into the tube nest with a resultant decrease in velocity. The air offtake consists of 2 parallel plates that extend the whole length

A number of very interesting details of the condenser are clearly indicated in Fig. 13a, from which it will be noticed that an exhaust connecting casting, made in 2 parts with internal flanges, adapts the turbine exhaust to the condenser inlet, being offset from the center line of turbine exhaust by about 5½ ft.

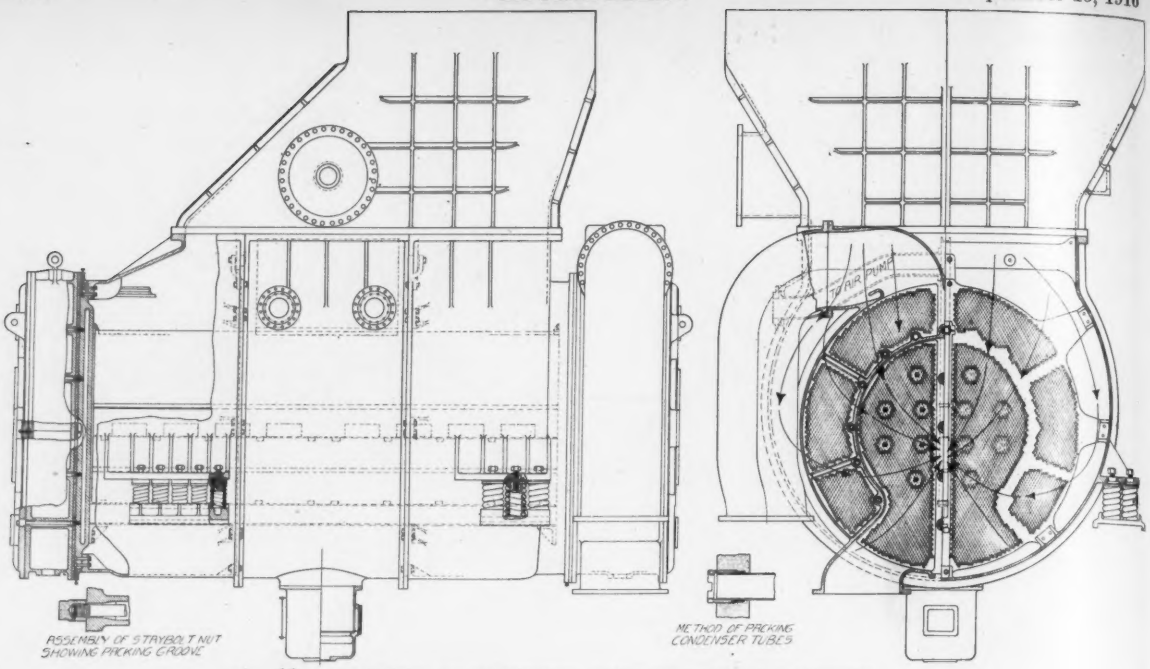


FIG. 13A. DRAWING OF CONDENSER SHOWING SPECIAL FEATURES

The condenser exhaust connection is bolted directly to the turbine exhaust nozzle, no expansion joint being used, the condenser being supported in part by the turbine's exhaust nozzle and in part by a system of spring supports. The spring supports care for any longitudinal movement of the turbine and condenser due to expansion in the turbine, and also care for any expansion of the condenser itself. The design of the spring supports was an interesting problem, for it was necessary that they be so proportioned that there would be no tendency for the exhaust flange to assume any position other than exactly parallel to the turbine's exhaust flange.

The details of the spring supports are clearly shown in the drawing. Ribbed lugs are cast on the condenser shell to support the weight, which is transmitted to the

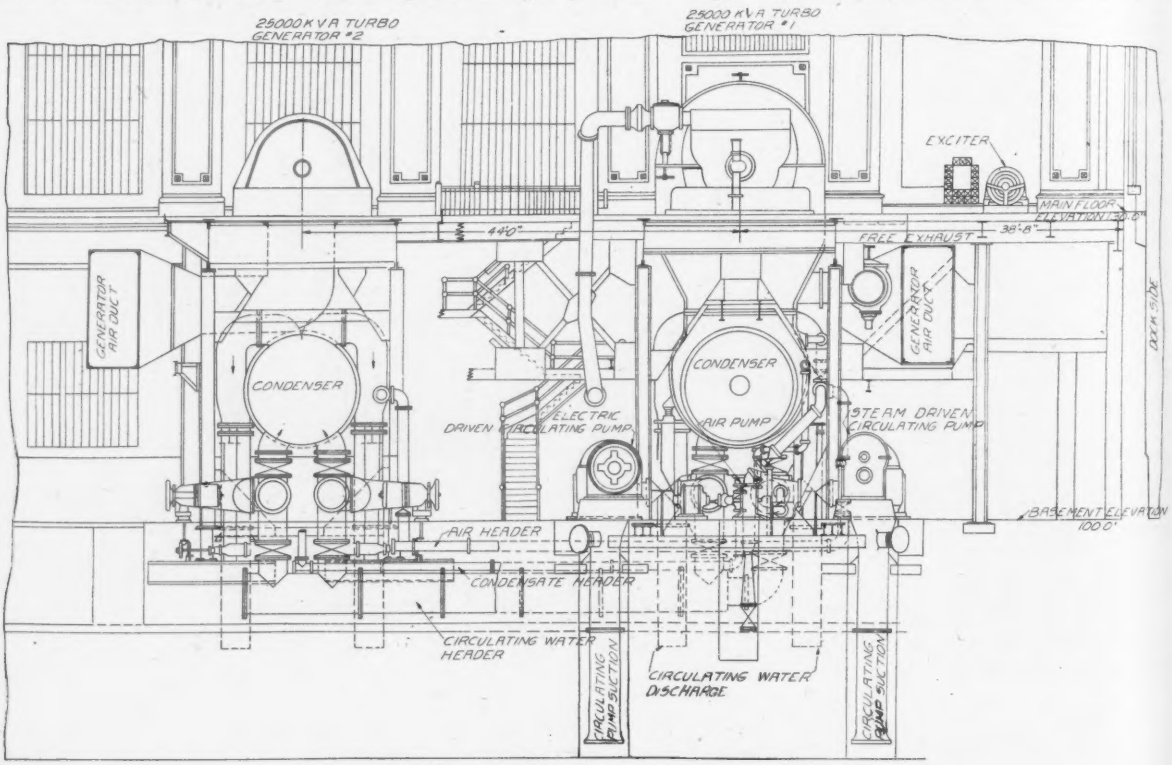


FIG. 15. END SECTION OF TURBINE HOUSE

concrete pier foundation by a double row of stiff spiral springs resting on a cast-iron shoe, forming the top surface of the pier. A threaded steel bushing is inserted in the condenser lug. Into this bushing the tap bolts screw and bear down upon the cap in such a manner that the weight of the condenser may be transmitted to the foundation from the condenser lug through the tap bolts by means of the threaded bushings, from the tap bolts to the steel cap, and from this cap to the spring and to baseplate. The tap bolts, however, are not actually required to carry the weight of the condenser except at the time when they are screwed down in order to permit the insertion of the steel liners. After this the tap bolts are backed off and the weight is transmitted directly from condenser lug to steel liner and then to spring bearing cup. The thickness of the steel liners represents the carefully calculated compression of the spring necessary to give the desired relief of the condenser weight on the part of the springs.

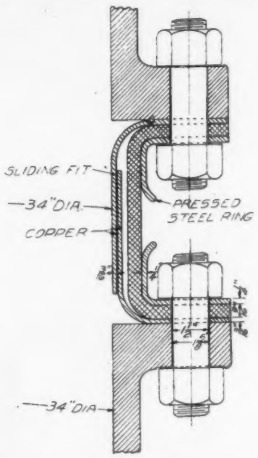


FIG. 14. SECTION OF EXPANSION JOINT, CONDENSING WATER PIPING

There is a double row of springs at the water inlet end of condenser, 6 springs being used for each of the 2 lugs. At the opposite end of condenser 5 springs per lug, arranged in a single row, are utilized, these springs not being so stiff, but are compressed more than the springs at the water inlet end.

The path of the steam through the condenser is best shown by arrows. Air is extracted at the center of the condenser; i.e., along the central axis of the tube plate, which extends the active length of condenser. Two pipes provide the outside connection to air pumps. A built-up section of steel plates and channel irons provides for collecting the air and permitting it to be extracted by connection to the pipes. This built up section, "air collecting box," is supported at the 2 ends by a vertical cast-iron beam through brackets, and at the center by cast-iron tube support plates. The vertical beam also serves to aid in supporting the tube plates.

Details of the tube plates, water box, and cover plates assembly, also stay bolts, are shown in the cross section at the lower left-hand corner of the drawing. The tube plates and water box covers are split vertically along the central line of condenser. Lifting lugs are provided on the covers so that they may be readily removed. Manholes are also provided.

Cooling water is taken from and returned to the river by concrete tunnels located under the floor of the turbine house, the intake tunnels running beneath the discharge tunnels as shown in Fig. 17. The intake structure at the dock has 3 15-ft. gates located in a concrete wall, and back of these are revolving screens, Fig. 16, carried on sprocket wheels at the top and bottom, driven by a motor connected to the upper sprocket wheels and traveling 4 ft. per minute. This screen is cleared of rubbish at the upper end by means of a water spray which washes the dirt and trash back into

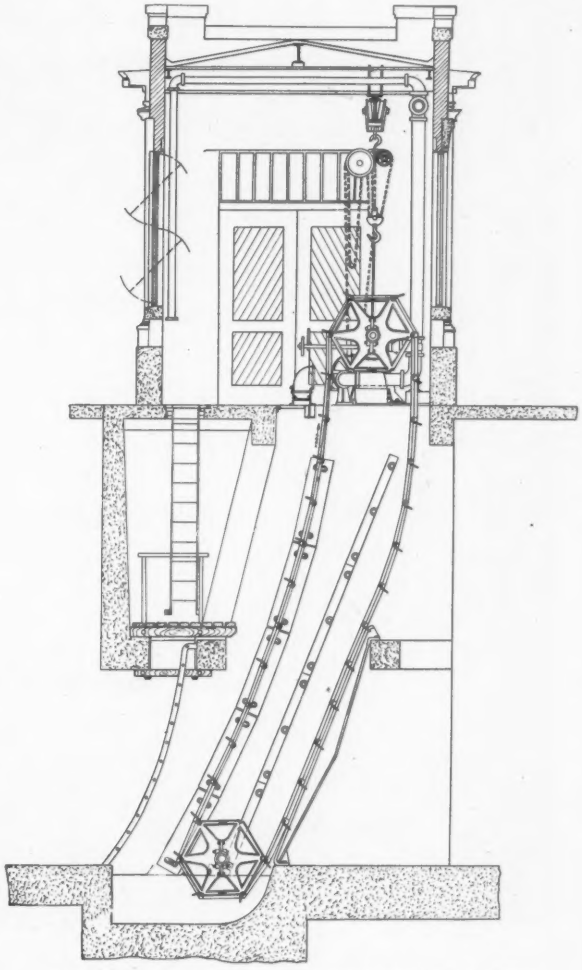


FIG. 16. SECTION OF REVOLVING INTAKE SCREEN

the river through the discharge tunnels. The chamber for these screens is 10 ft. wide, and back of these, the canals are reduced in section, being 9 ft. 4 in. wide and 8 ft. high with 11-ft. gates. Discharge and intake tunnels are passed by each other so that the suction from the circulating pumps is a direct lift from the intake canals.

Two methods of supplying water to the condensers are provided, one pump for each condenser, Fig. 13, being motor driven by a 350-hp. Westinghouse constant speed motor through a flexible coupling, the pump being a double suction volute, with a capacity of 24,000 gal. per minute, at 32.5 ft. head. The other unit, which

is the same type pump, Fig. 18, is driven by a Westinghouse horizontal type turbine of 350 hp. capacity and running at 1800 r.p.m. through a set of self-alining double helical gears having a reduction ratio of 5 to 1. The turbine pump is the regular source of supply. The motor driven pump is cut in and out of service as required to keep the temperature of the cooling water between definite limits, a thermostat cutting in the motor when the cooling water temperature reaches the high limit and cutting out the motor when the low limit is reached. Cooling water discharges by gravity vertically to the discharge tunnels.

Expansion in the intake and discharge pipes is provided for by a special type of joint which is shown in cross-section in Fig. 14, and is also shown in the lower left-hand corner of the cut, Fig. 13, showing the motor driven pump side of the condenser. This joint consists of steel rings attached to the flanges, having between the flanges a sleeve of 5-ply Sea Island duck, 30 oz. to the yard, with a coating of 45 per cent pure Para gum 1/32-in. thick between the plies, and 1/16-in. thick on the outside, the gum being pressed in with a mold and vulcanized in place. A space of ¼ in. is allowed between the flexible sleeve and the inside copper sleeves. These copper sleeves form a sliding joint 34 in. inside diameter, the copper being 3/16-in. thick.

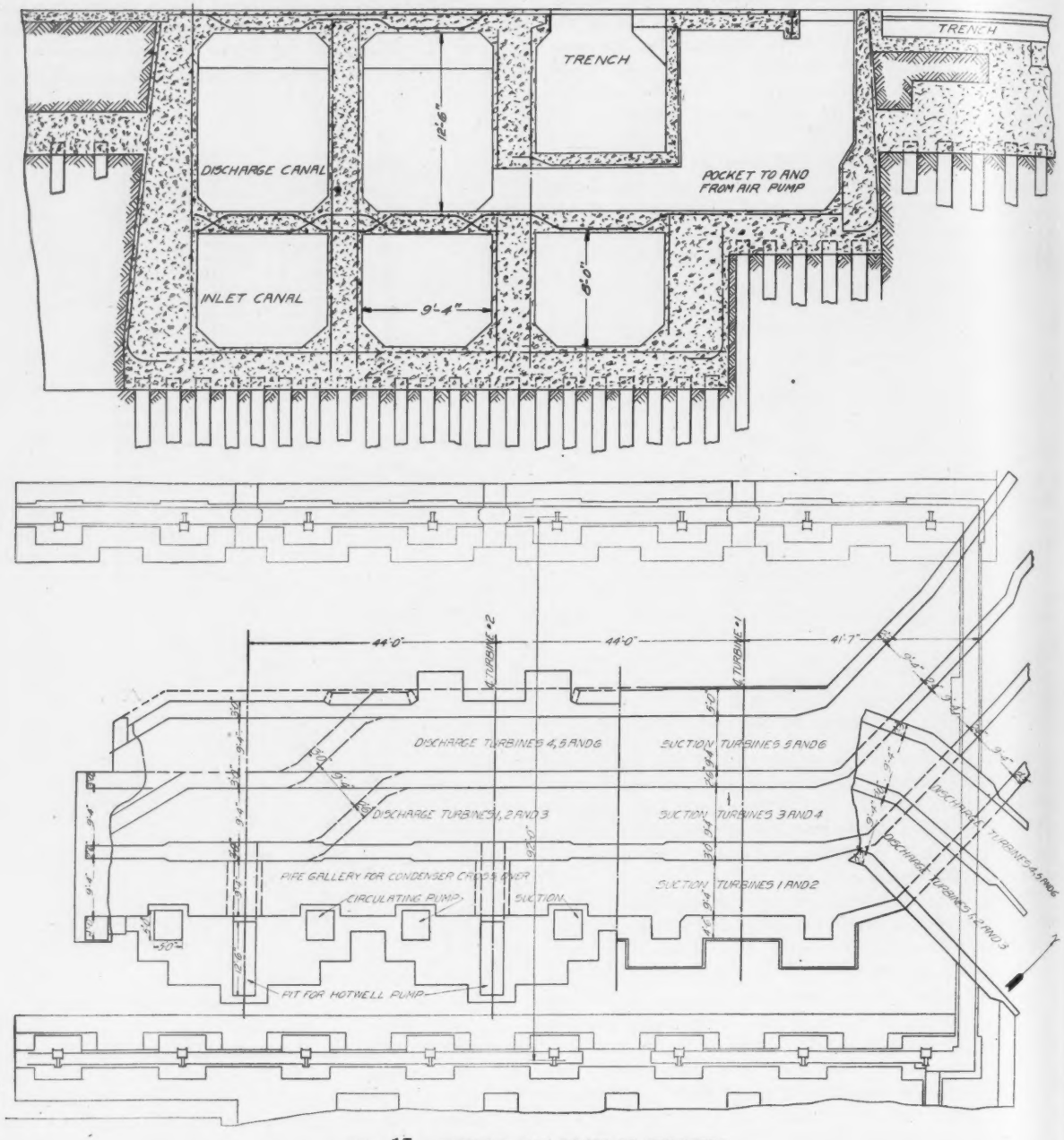


FIG. 17. SECTION AND PLAN OF TUNNELS

The discharge canals are 2 in number, 12 ft. 6 in. high by 9 ft. 4 in. wide, with an auxiliary chamber for

making connection to the condenser discharge pipes. At the outlet to the river, the channels are 12 ft. wide by 8 ft. deep, with 12 ft. gates. The entire tunnel structure is carried on piling 2 ft. 2 in. centers, has side walls 5 ft. thick at the bottom, 3 ft. thick at the top, dividing walls 2 ft. 6 in. and 3 ft. thick, a floor thickness of 3 ft., and a roof of reinforced concrete 18 in. thick with openings at various necessary points fitted with corrugated steel cover plates.

For removing the air from the condensers, a Westinghouse-Le Blanc pump is provided, having a capacity of 37.5 cu. ft. of free air per minute and operating at an absolute pressure of 0.76 in. of mercury. This pump is driven by a 100-hp. constant speed Westinghouse induction motor, direct connected. The generator end of the turbines will be described in a further article which deals with the electrical equipment of the plant.

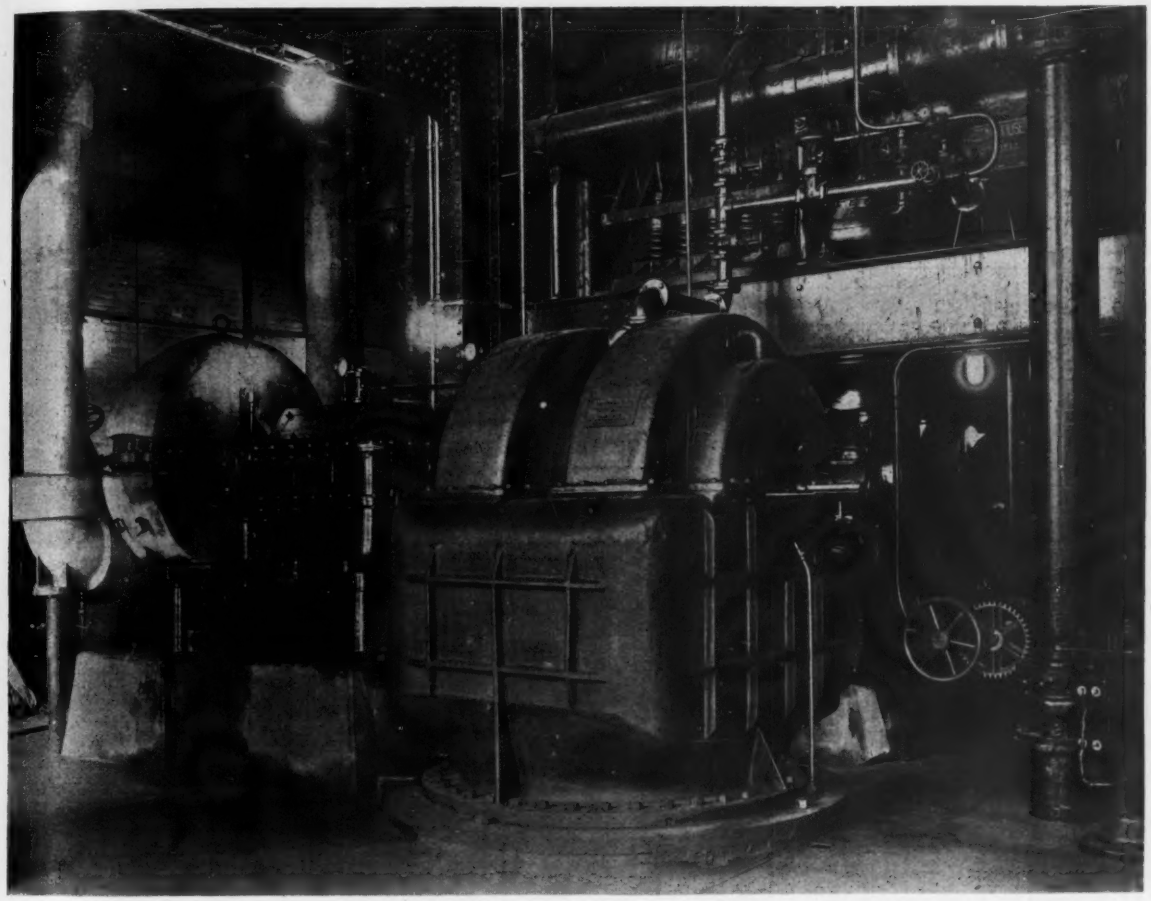


FIG. 18. TURBINE DRIVEN CIRCULATING PUMP

Auxiliary Equipment

For assisting in the operation of the turbines, there are located in the turbine room control panels two boards being used for each turbine and condenser. These contain a General Electric indicating, recording and integrating flow meter for registering the steam used, a pen recording thermometer for the steam temperature of the superheater, recording pressure gage and 2-pen recording thermometer giving the inlet and discharge temperature of the cooling water, and a 2-pen recording thermometer registering the steam temperature at the top of the condenser and the temperature of the condensate in the heater well at the bottom of the condenser. There is, also, a board containing the frequency meter, indicating wattmeter, engineers' signal lamps, and a remote control switch to operate the main stop valve on the turbine steam supply, and a separate synchroscope is provided for use in paralleling the generator units.

In the boiler room, a panel board is provided for each boiler, containing a recording thermometer for the gas temperature at the uptake, thermometers showing the water temperature at the inlet and discharge of the economizer, a recording pressure gage showing the wind pressure in the stoker air chamber, a tachometer showing the speed of the stoker shaft, and a gage showing the draft over the fire and the draft in the intake. There is, also, a U-tube gage showing the pressure in the main forced air duct; controllers for the stoker motor, and the forced draft fan are located beside the panel board, thus making this an operating center from which the entire boiler action may be controlled and studied.

Indications on the boiler control panel showed a boiler pressure of 220 lb., an inlet temperature to the economizer of 195 deg., an outlet temperature of 260 deg. for the feed water, a flue gas temperature at the

uptake of 440 deg., 4.15 in. of water pressure in the forced air duct, and 1.7 in. of draft in the uptake. Equipment on the boiler panel boards consists of Columbia recording instruments made by Schaeffer & Budenberg.

For operating the clamshell gates of the coal and ash chutes, compressed air is used, also for signals and for cleaning about the plant, and to provide the air for this purpose a straight line air compressor, made by the Ingersoll-Rand Co., is installed, with capacity of 100 cu. ft. of air per minute at 100 lb. pressure. A second compressor is also to be installed of the same type, having a capacity of 225 cu. ft. of air per minute, both being motor driven, the smaller compressor has a Westinghouse constant speed 15-hp. motor connected by belt drive, and started and stopped automatically by pressure variation to low and high limits in the air receiver.

For supplying lubrication to the machinery, an oil circulating system is installed, consisting of a Richardson-Phenix oil filter, which is used for new and makeup oil only, and is located in the turbine room basement. Return oil flows to a 2-barrel tank located under the turbine room floor, and is forced by air pressure to a storage tank in the boiler house roof. A second tank is provided for use when new oil is being tested. From these overhead tanks the oil flows by gravity to a small storage tank on each turbine, and after use is forced by a 3-in. centrifugal pump, furnished by the Lea-Courtenay Co. and having a capacity of 150 gal. per minute and driven by a 7.5-hp. General Electric constant speed motor, to the storage tank. The oil pump unit is provided in duplicate.

A drinking fountain system is provided through the plant, with fountains located at convenient points, the water being cooled by a 2-ton refrigerating plant furnished by the Brunswick Refrigerating Co., of Brunswick, N. J., this plant also manufacturing 500 lb. of ice a day for use in the kitchen and restaurant which is operated at the plant for the benefit of employes.

For the handling of parts during repairs and overhauling, a 100-ton Morgan Engineering Co. crane is installed in the turbine room, having a span of 87 ft.

TABLE I. EQUIPMENT OF COAL TOWER AND BUNKER

No.	EQUIPMENT	KIND	SIZE	OPERATING CONDITION	MANUFACTURER
1	Hoisting Engine	Two Drum	24-in. Drums 200 r.p.m.	180 Tons per Hour	Maine Electric Co.
1	H. E. Motor	Induction	410 hp. 200 r.p.m.	Direct Connected to Engine	General Electric Co.
1	Traversing Engine	Single Drum	30-in. Drum	Gear Driven Motor	Maine Electric Co.
1	T. E. Motor	Induction	75 hp.	Constant Speed	General Electric Co.
1	Feeder	Apron	5 ft. Wide, 16 ft. Long	Gear Driven Motor	Stephens-Adamson Co.
1	Feeder Motor	Induction	7.5 hp.	Constant Speed	General Electric Co.
2	Crushers	2-Roll	36 in. by 36 in. Rolls	Gear Driven Motor	Robins Conveying Belt Co.
2	Crusher Motors	Induction	35 hp.	Constant Speed	General Electric Co.
1	Conveyor	Belt	30 in. by 161 ft. Long	300 Tons per Hour	Robins Conveying Belt Co.
1	Conveyor	Belt	30 in. by 120 ft. Long	200 Tons per Hour	Robins Conveying Belt Co.
1	Conveyor Motor	Induction	20 hp.	Constant Speed	Westinghouse Electric & Mfg. Co.
1	Conveyor Motor	Induction	10 hp.	Constant Speed	Westinghouse Electric & Mfg. Co.
1	Coal Bucket	Clamshell	1½ Ton		Hayward Co.
1	Automatic Skip Hoist	Balanced	2 Ton Buckets - 100 Tons per Hr.	Full Automatic	Maine Electric Co.
1	Skip Hoist Motor	Induction	25 hp.	Constant Speed	General Electric Co.
1	Elevator	Electric Freight	7½ Ton	50 ft. per Minute	Reedy Elevator Co.
1	Elevator Motor	Induction	40 hp.	Constant Speed	Lincoln Electric Co.

TABLE II. PRINCIPAL EQUIPMENT OF BOILER HOUSE

EQUIPMENT	KIND	SIZE	OPERATING CONDITION	MANUFACTURER
8 Boilers	B & W. Cross Drum	1373 hp. on 10 lb. per sq. ft. Basis	225 lb. Press. 150 deg. Superheat	Babcock & Wilcox Co.
8 Superheaters	Flash Type	1711 sq. ft. Heating Surface	150 deg. superheat	Babcock & Wilcox Co.
8 Soot Cleaners	Steam Blow		Live Steam	Vulcan Soot Blower Co.
8 Stokers	Underfeed	16 Retort - 15,000 lb. Coal per Hour	Continuous Dumping	Sanford Riley Stoker Co.
4 Reeves Transmissions		Class F - No. 6½	Variable Speed	Reeves Pulley Co.
8 Stoker Motors	Induction	12 hp.	Four Speed	General Electric Co.
8 Forced Draft Blowers	Turbovane	60,000 cu. ft. Min. at 7 in. St.Pres.	2 Speeds - Motor Driven	B. F. Sturtevant Co.
8 F. D. B. Motors	Induction	150 hp.	2 Speed	General Electric Co.
8 Economisers	C. I. Tube	7750 sq. ft. 40 by 12 by 12 ft.	1 Economizer per Boiler	B. F. Sturtevant Co.
8 Induced Draft Fans	Multivane	106,000 cu. ft. Gases 400 deg. F.	Constant Speed Motor Driven	B. F. Sturtevant Co.
8 I. D. F. Motors	Induction	100 hp.	Constant Speed	General Electric Co.
2 Meters	Cochrane Metering	10,000 hp. 500,000 lb. per Hour		Harrison Safety Boiler Works
1 Metering Tank	Blow Off	200,000 lb. per Hour		Harrison Safety Boiler Works
1 Metering Tank	Feed Water	1,000,000 lb. per Hour		Harrison Safety Boiler Works
3 Boiler Feed Pumps	5 Stage Centrifugal	1000 gal. per Minute	700 ft. Total Head	International Steam Pump Co.
3 B. F. P. Turbines	Horizontal	250 hp.	190 lb. Steam, 150 deg. Superheat	Westinghouse Electric & Mfg. Co.
1 Fire Pump	2 Stage Centrifugal	1000 gal. per Minute	110 lb. Total Head	Lea-Courtenay Co.
1 Fire Pump Motor	Induction	100 hp.	Constant Speed	Westinghouse Electric & Mfg. Co.
1 Air Compressor	Straight Line	225 cu. ft. per Minute	100 lb. Pressure	Ingersoll-Rand Co.
1 A. C. Motor	Induction		Constant Speed	Westinghouse Electric & Mfg. Co.
2 Service Pumps	Single Stage	500 gal. per Minute	110 lb. Total Head	Lea-Courtenay Co.
2 S. P. Turbines	Horizontal	22 hp.	150 lb. Gauge, 150 deg. Superheat	Westinghouse Electric & Mfg. Co.
1 Air Compressor	Straight Line	100 cu. ft. per Minute	100 lb. Pressure	Ingersoll-Rand Co.
1 A. C. Motor	Induction	15 hp.	Constant Speed	Westinghouse Electric & Mfg. Co.
2 Coal Larries	Weighing	15 Ton	Motor Driven	Robins Conveying Belt Co.
2 Stacks	Steel-Brick Lined	15 ft. 4 in. by 250 ft.		
2 Locomotives	Electric Storage Battery		Storage Battery	Westinghouse Electric & Mfg. Co.
16 Meters	Steam Flow			General Electric Co.
1 Charging Equipment	Motor Generator	15 kw.	For Electric Locomotives	General Electric Co.

TABLE III. MAIN EQUIPMENT OF TURBINE HOUSE

No.	EQUIPMENT	KIND	SIZE	OPERATING CONDITION	MANUFACTURER
2	Generators		25,000 k.v.a.	132,000 v. 3 hp. 60 cy. 1800 r.p.m.	General Electric Co.
2	Exciters	Direct Connected	100 kw., 250 v. Compound Wound	1800 r.p.m.	General Electric Co.
1	Exciter	Shunt Wound	150 kw. 250 v.	Reserve Equipment	Allis-Chalmers Co.
1	Exciter Motor	Induction	220 hp. - 1175 r.p.m.	Reserve Equipment	Allis-Chalmers Co.
2	Turbines	Curtis - Horizontal	25,000 kw. - 12 stage	190 lb. Steam, 150 deg. Superheat	General Electric Co.
2	Condensers	Two Pass Surface	32,000 sq. ft. - 255,000 lb. per hr.		Westinghouse Electric & Mfg. Co.
4	Circulating Pumps	Horizontal-Centrifugal	24,000 gal. per Min. 45 ft. Max. Hd.	Turbine Driven	Westinghouse Electric & Mfg. Co.
2	C. P. Turbines	Horizontally Split	350 hp.	190 lb. Steam, 150 deg. Superheat	Westinghouse Electric & Mfg. Co.
2	C. P. Motors	Induction	350 hp.	Constant Speed	Westinghouse Electric & Mfg. Co.
2	Air Pumps	Le Blanc	37.5 cu. ft. Free Air per Min.	Motor Driven	Westinghouse Electric & Mfg. Co.
2	Air Pump Motors	Induction	100 hp.	Constant Speed	Westinghouse Electric & Mfg. Co.
2	Condensate Pumps	Centrifugal	500 gal. per Minute	Turbine Driven	Westinghouse Electric & Mfg. Co.
2	C. P. Turbines	Horizontally Split	20 hp.	140 lb. Steam, 150 deg. Superheat	Westinghouse Electric & Mfg. Co.
1	Crane	Electric Traveling	100 Ton - 94 ft. Span	2-50 Ton, 1-10 Ton, Hooks	Morgan Engineering Co.
2	Air Washers	Spray System	60,000 cu. ft. Air per Minute	Motor Driven Pumps - 10 hp.	Spray Engineering Co.
2	Oil Pumps	Centrifugal	3-in. -150 gal. per Min.	Motor Driven	Lea-Courtenay Co.
2	Oil Pump Motors	Induction	7.5 hp.	Constant Speed	General Electric Co.
1	Oil Filter			For New & Makeup Oil Only	Richardson-Phenix Co.

9 in. This carries 2 50-ton hooks and carriages, having a lifting speed of 8 ft. per minute, and one 10-ton hook having a speed of 25 ft. per minute. The lift is 65 ft. 6 in. On each large hook a 52-hp. motor is provided, and on the small hook a 22-hp. A 52-hp. traversing motor operates the bridge at a speed of 150 ft. per minute, and two 15-hp. motors traverse the hook carriages at 150 ft. per minute. Small hand hoists are provided which may be put in position at various points in the plant for the temporary handling of parts during overhauling.

For the control of the condensers, Pratt & Cady swing checks are provided on the double discharge for cooling water, and Chapman motor-operated gate valves on the inlet piping. On the turbine outlet a Homann & Maurer mercury barometer is connected, which showed 28.8 in. vacuum on 29.96 in. barometer reading. There are, also, gages on the inlet and discharge of the Le Blanc air pump, the inlet gage showing 28.9 in., and the discharge 15 in. vacuum. An Elliott twin strainer is installed in the discharge from the air pump to catch any foreign matter and prevent returning it to the boiler feed tanks. On the cooling water inlet is installed a Homann & Maurer thermometer, showing 68 deg., and on the outlet a Homann & Maurer mercury thermometer, also a Foxboro recording thermometer, which showed 75 deg.

Told at Forty

THINGS look different at forty. I know, for I am writing this on my fortieth birthday. Life isn't any more serious than it ever was, perhaps less so; it is not nearly so much of a problem; it is more comfortable.

You see I am an employe—one of the millions who get pay from somebody or somebody else. I have always been an employe and, I suppose, always shall be. Somehow, there doesn't seem to be enough employing to do for all of us to have a chance at it. And, besides, most of us don't know enough to do employing, yet nine-tenths of us feel that we are superior to men who pay us, and we criticise their methods and their actions. Not openly, more's the pity; the average employer would be glad to hear decent criticisms, decently made. We sneak. We tell the other fellows and our friends outside how "slow" and "mean" the boss is.

When I began to work I didn't see any of these things quite this way, didn't see some of them this way at all. Of course, I wasn't forty then, but I was on the way to it. So are you my brother, unless you have reached or passed it.

I have had 3 jobs since my twenty-first birthday, 4, 7, and 8 yr. Left the first one to go to the second, and the second to go to the third; and am still at the third. To do better each time? No. To do worse from a money standpoint. But to apply some of these things I learned in the previous job. I did get my wages increased occasionally while at the first two jobs. But I wouldn't have got a worth-while promotion in a thousand years. Why? Don't ask me—just read over again the first part of this talk.

Eleven years to learn something—not much even then—of my duty as an employe. And I learned not to lay any particular stress on my employer's duty to me; because he really doesn't owe me any duty, unless my conduct and my work are such as to impose an obligation upon him, in which event he'll be glad to "square" up.

Is this a new one? It was to me, once. But I'm fixed in it now. I have said that I am an employe. And yet I have spent the last 8 yr. working for myself. Just as surely as though I owned a business. How? By doing the best I know for my employer, every minute of my working day. It's easy when you get into it.

I tumbled to the fact that there is only one fellow in the world and that fellow is myself. He hindered me a good many years; he's helping me now.

Some folk say I made a wonderful jump to where I am. They're wrong. I've gone up slowly, very slowly, it has seemed sometimes. In obedience, however, to the law of business gravitation, the law that inexorably says, "up if you're worth it" and "down if you're not."

I haven't worried about my job since I got the real hang of things. Once, when I had a good offer from another city, my employer said, "I would like to see you stay here." Not a word about advancing my wages to meet that offer. Not a word for 6 mo. after, for I stayed. Then, that much and more.

Some of the other fellows said harsh things about that man, just as I said them about former employers. And they are listless and uninterested, and jump when the bell rings.

Sometimes they tell me I'm lucky, when there's no such thing as luck. They have not learned—some of them are 'way past forty and will never learn.

I am happy in my work; my digestion and nerves are good. Life is beautiful and richly worth living.

I've saved a little money, and by the way, maybe I can quit and rest awhile if I want to.

Yes, things do look different—at forty.—The Illuminator.

THE METHOD of handling orders from customers in foreign countries has been arranged by the Stow Manufacturing Co., of Binghamton, N. Y., which affords great convenience and would seem to be desirable for many classes of apparatus.

By this arrangement, orders made out directly to the Stow Mfg. Co. may be placed at the nearest foreign office of the American Express Co., and will be transmitted direct to the Stow Co. The express company will also open credits or accept payments for the account of the Stow Co., and will handle details of shipping, customs, etc. No buying commission is charged by the express company, only a reasonable charge being made for handling credits and remittances, and for transportation of goods.

The offices of the express company which are available cover practically all the larger cities of Europe, with the exception of the central powers, and also include Buenos Aires, Manila and Hongkong.

U. S. CIVIL SERVICE COMMISSION announces examinations, Sept. 20 and 21, for junior computer, to fill vacancies in the Bureau of Mines, Pittsburgh, Pa., at salaries ranging from $900 to $1200; and for mineral examiner, in the General Land Office at $1320. Apply for Form 1312, giving the title of the examination desired.

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Letting Subordinates Conduct Minor Investigations

Presumably every "chief" in charge of a plant large enough to require several assistant engineers has ambitions to build up a peerless organization and to maintain it at a high level of efficiency. These good intentions are sometimes befogged by the policy of keeping subordinates too strictly on purely routine work. Constant repetition of duties, varied only slightly through changes in load conditions, needs now and then to be succeeded by fresh and stimulating tasks if real development of the staff is to be obtained, and one of the best ways in which the chief can bring this desirable change to pass is to institute the investigation of some particular problem in the station and call upon one or more assistants to take an active part in the analysis.

Such an investigation may be considered a minor study in comparison with some of the problems which are put up to the chief by his superiors, but it affords in many cases ample opportunity for the display of initiative by the assistants charged with the details. Such an inquiry, for example, might be directed into the power requirements of the coal-handling system, into the possibility of cutting down the energy consumption for station lighting, or into the accuracy of draft control. Without abating his responsibility for the recommendations, if any, resulting from the investigation, the chief engineer bent on developing his staff will share such work with his subordinates in a way that gives one or more at a time a real chance to attack the problem.

This may mean allowing one or two assistants time enough off to visit other plants in the reasonable vicinity and see thoroughly just what their practice is along the particular lines up for consideration. The chief may decide to go himself after the rough notes of the study are before him; but by letting his subordinate engineers break away from routine and bring home some fresh ideas on their own account, he accomplishes something that cannot easily be weighed in the direction of stimulating their powers of observation, recording and deduction. Again, with the right kind of executive "timber" in his staff, the chief may decide to let one or another of his subordinates conduct a series of tests with the auxiliary equipment, holding the under man responsible for results and not hampering him more than is absolutely necessary with fussy detailed instructions.

In such a study as that of station lighting, for instance, the chief may go so far as to authorize his second in command to obtain approximate cost data from manufacturers' representatives as to new types of reflectors, and may encourage the assistant engineer to set up a trial installation in which some improved lighting unit figures to advantage. The chief may ask his right-hand man to submit an informal report on the subject, with cost estimates and recommendations. All such work may have to be very carefully checked, of course, and it can be done in a way not to give offense to the under engineer who has put, it may be, a good many nights of outside reading and some hours of hard work on the equipment itself. Some engineers apparently never think of letting those just below them share in the minor investigations for which most stations offer so attractive a field, but the policy is certainly worth considering.

First Ohio Boiler Inspectors' Convention

THOSE INTERESTED IN UNIFORM BOILER LAWS AND CODES ASSEMBLE AT COLUMBUS, AUG. 17 AND 18

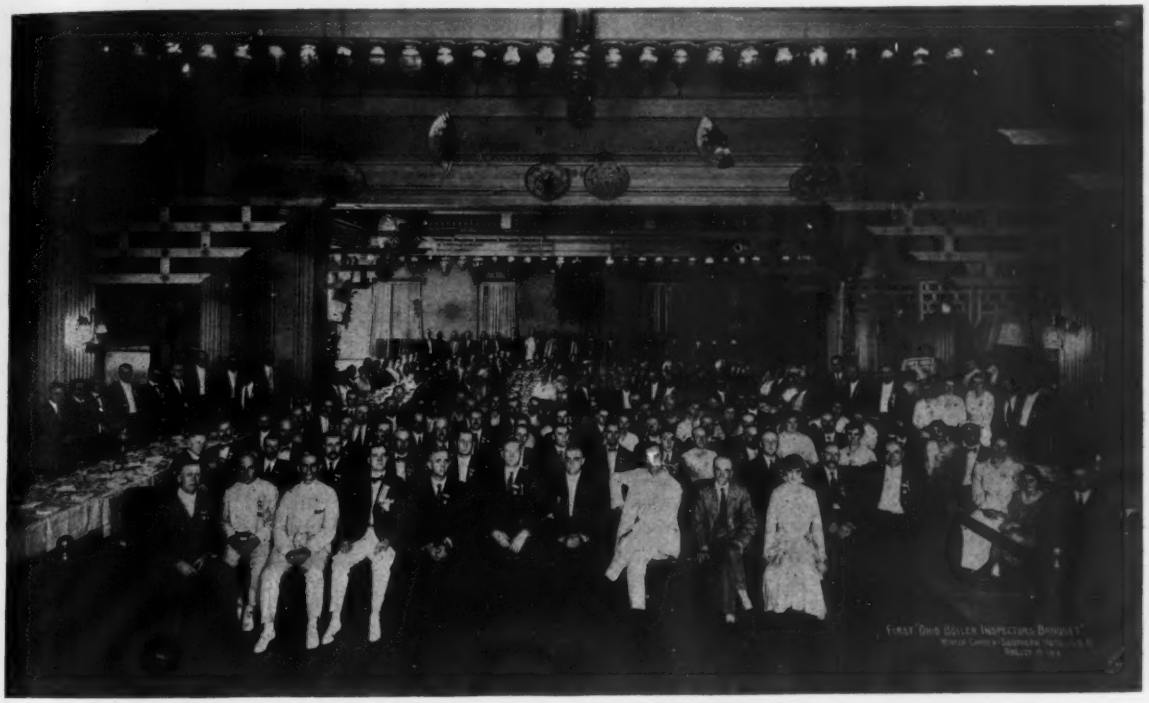
PERHAPS one of the most interesting and unique conventions held recently was that of the boiler inspectors employed by the state and by the liability insurance companies, which met in the Ohio House of Representatives on Aug. 17 and 18, and was presided over by Chief Deputy J. C. Callery of the Division of Boiler Inspection under the Industrial Commission.

The principal object of the convention was to further the matter of uniformity, both in the construction of steam boilers, and the inspection of boilers in operation throughout the state, and under the immediate supervision of the Ohio Board of Boiler Rules. It is felt that considerable progress was made, and great benefits will follow from the meeting, especially in the matter of uniformity, from the discussions which were brought out along these lines.

At the first convention, the address of welcome was delivered by Hon. Wallace D. Yaple, Chairman of the Industrial Commission. During his remarks he took occasion to give a short history of steam power, and how helpless the industry of the world would be without the steam engine, and its necessary corollary, the steam boiler, and especially dwelling upon the importance of the proper inspection of boilers for the safety, not only of the operators of them, but for the general public. It was also urged that the matter of uniformity was one of very great importance, and any measures which would tend to advance progress in that direction should be adopted.

Hon. Percy Tetlow, a former member of the Legislature, and member of the Constitutional Convention, now an organizer for the United Mine Workers of Ohio, addressed the convention on "Conservation and Law Enforcement." He took occasion to speak of the enormous waste in the mining of coal, and its attendant influence on the cost of power as generated through the steam boiler. The wastage due to the mining methods was placed as high as 40 per cent.

Mr. Tetlow pleaded that something should be done to secure a greater per cent of the coal yet unmined. Speaking of the mining of coal, he referred to the enormous loss of life and what steps had been taken to prevent accidents, and stated that while much had been done, considerable improvements were still to be made, and left the thought with the convention that it was a duty imposed upon each one to do everything in his individual power to prevent loss of life or injury to person or property through preventable causes. He stated that the average death rate among miners in the United States was the highest of any in the world, being 4 per 1000 annually, while that of Austria was 1.04; France, 1.17, and England 1.43. This was due not to the fact that this country did not have competent mining engineers and mine managers, but from lack of discipline in the mines, and lack of law enforcement. In European countries law violations were punished, while owing to free and easy methods in this country, offenses were overlooked. Part of these deaths were due to the method



OHIO BOILER INSPECTORS' BANQUET AT SOUTHERN HOTEL, COLUMBUS, OHIO

of mining, the Long Wall system being used abroad.

H. A. Baumhart, Vice-Chairman of the Ohio Board of Boiler Rules, gave a history of the insurance of steam boilers, and the inspection and protection features connected with the early companies who engaged in this form of insurance. In 1838 the Federal Government passed an act formulating rules governing the inspection of steam vessels carrying passengers. This law was amended in 1852 to include freight steamers, and in the next 5 yr. the number of explosions amounted to 7 as against 50 for the preceding 5 yr. This law was fought by boiler owners and engineers, just as attempts at boiler legislation are opposed today. The speaker urged standardization, both as to construction and methods of inspection, and ventured the conclusion that it was the most important subject before the industry. He also mentioned that Massachusetts was the first state to have compulsory inspection, Ohio following after. He stated that from his experience the boiler manufacturers were responding nobly to the changed conditions occasioned by the inspection law, and were assisting in its operation. He urged the necessity of uniformity, to the end that the life of the people coming in contact with the boilers be better conserved, and that property damage be averted, as well as making for progress because of one standard, both in the construction and inspection of boilers.

At the Thursday afternoon session, J. F. Whiteley of the Fidelity and Casualty Co., of New York, gave an entertaining and instructive address on "Duties of a Boiler Inspector. Going back 26 yr., Mr. Whiteley gave reminiscences of a time when there were probably less than 100 boiler inspectors in the entire United States, while at the present day there are more than that number in the state of Ohio. Mention was made of the old drop-flue boiler, the double-decked cylinder boiler, and triple-draft Hennessy boiler, now happily passed to the scrap pile, and that the few "misfits" yet remaining are fast disappearing. Continuing, the speaker pointed out the improvement in the workmanship on the present boilers as compared to the methods of drifting the rivet holes until it was possible to force the rivet through; that it was no longer considered possible to set the sheets up loosely and expect the calking tool to cover up the poor work and make the boiler tight for a short time; also that "tooth pick braces" were obsolete in these days of high pressure, and that the use of sledge hammers to straighten out "kinks" was no longer tolerated. Speaking of reports, and what the reports indicated, the speaker laid particular emphasis on the fact that the man in the office was able to judge something of the character and ability of the inspector by the manner in which he prepared his reports, and referred particularly to the necessity of having all data correct.

Necessity of boiler inspection codes was treated by Fred R. Low. The speaker took occasion to impress upon his audience the tremendous power stored in a boiler, and mentioned something like 163,000,000 ft.-lb. of energy in a 72-in. by 18-ft. boiler at 150 lb. pressure. The necessity for boiler inspection was apparent, and since various builders differ considerably on boiler designs, a code of uniform application would be beneficial to both the manufacturers and the users of steam boilers.

Reasons why a uniformity of rules would improve the standards of inspection were presented by Thomas E. Durban, chairman American Uniform Boiler Law Society, Erie, Pa., in a paper on "The Advantages of a Uniform Boiler Inspection Code." He stated that many of the present-day difficulties resulted from a lack of uniformity.

George A. Luck of Massachusetts, gave a short talk relating how the boiler inspection law was applied in his home and mentioned some of the difficulties encountered by his Board. He urged that a uniform code be formulated and adopted by all states at as early a date as possible. George A. O'Rourke, of the New York State Industrial Commission, also gave a short talk in regard to his duties and the progress made in his state. Brief talks followed by different members, and considerable discussion of live subjects resulted at the close of the prepared papers.

On Thursday evening a banquet for 280 guests was held at the Winter Garden of the Southern Hotel.

At the Friday morning session Victor T. Noonan, Director of Safety of the Industrial Commission gave a lengthy address on "Why not Preparedness against Accidents?" going into detail as to the cause of accidents and the way to prevent them.

Frank M. Yeager of the Ohio Board of Boiler Rules, and representing the operating engineers, gave a short talk in which he deplored the present day tendency of men operating large factories to place a watch in the hand of a man to record the time required in each operation, and expressed the belief that this was the cause of more accidents than was generally credited. The speaker urged the benefits to be derived from proper inspections, and mentioned instances illustrating his points.

F. D. Converse of the Ohio Brotherhood of Threshermen, although in poor health, addressed the convention briefly, and expressed the thought that the time would come when the threshermen would come under the inspection department, and have their boilers examined for safety. The speaker mentioned some of the obstacles in the way, especially referring to the difficulty of finding a time when it would be possible to inspect these boilers, and not discommode the farmers to whom the outfits belonged. Between March and June 1st, the speaker concluded, was the most favorable time for the inspection.

Many resolutions were suggested that the convention idea for the promotion of uniform boiler laws and codes be made a permanent annual occurrence. However, none was adopted for this purpose, the convention adjourned subject to the call of the Chairman Callery, as those directly in authority felt that there would be a meeting called in the very near future of committees from all the states directly or indirectly interested, also the A. S. M. E., for the purpose of preparing and adopting a uniform law and code.

Moving pictures, "From Ore to Finished Pipe," taken in the plants of the National Tube Co., were shown and explained by a representative of the company, Mr. Mason. The convention closed with an address by Governor Frank B. Willis, in which he complimented them on their attendance, and expressed the thought that much good would result from their meeting.

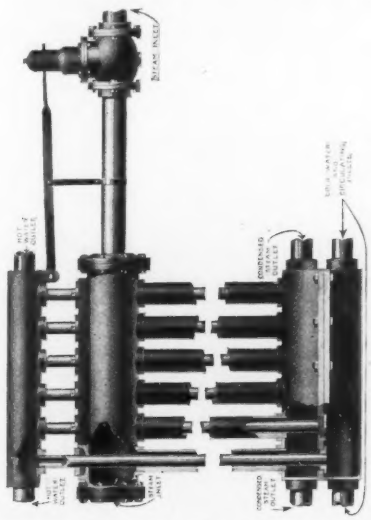
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Modern Automatic Water Heater

ESPECIALLY adapted for hotels, hospitals, laundries, swimming pools, and all buildings where large quantities of hot water are required, and where a constant steam supply, exhaust, high or low pressure, is available, the Madsen automatic water heater should be of interest to engineers. It may be installed flatwise or vertically, as desired.

As indicated in the accompanying illustration, steam enters the steam chamber or header, and then circulates through the steam pipes into the compound header shown on the right. Cold water enters the cold water compartment of the compound header and, passing



VIEW SHOWING COMPARTMENTS OF MADSEN HEATER

through brass pipes, is heated by the steam circulating in a counter-current direction and then enters the hot water header shown on the left.

Anchored at one end through the division wall of the compound header the brass pipes have, at the other end, a free movement through stuffing-boxes in the steam chamber, and are then connected to the hot water header.

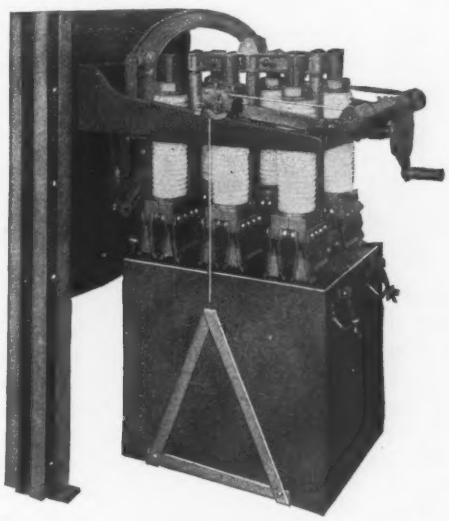
As the hot water is heated to the desired temperature, the brass pipes expand, moving a fraction of an inch, and this automatic movement closes the steam valve by operating a fulcrum rod connecting the valve and the hot water header. When the water becomes colder than the desired temperature, the contraction of the brass pipes causes the steam valve to open sufficiently to heat the water to the temperature for which the controlling valve is set.

When the use of hot water ceases, the steam supply valve is automatically closed by the expansion of the brass pipes, thus steam is used only while hot water is being drawn. Condensation is collected in one compartment of the compound header and may be returned to the boiler by gravity, or through a return trap, or by a feed pump, or wasted through a trap into drain or sewer.

This heater, which is manufactured by the Thermal Appliance Co., Inc., of New York City, is made in 5 sizes, from 1 to 8 pipes wide and 18 ft. in length, and covers a range of capacities from 100 to 8400 gal. per hour of hot water.

Tank Lifters for Medium Size Oil Switches

THE GENERAL ELECTRIC Co. has recently developed a number of tank lifting arrangements for oil switches of various forms and sizes, one type for comparatively small switches being described in the Aug. 1, 1915, issue of Practical Engineer. For switches of the next larger size and in capacities up to 1500 amp.



TANK HELD IN SUSPENSION BELOW CIRCUIT BREAKER BY MEANS OF TANK LIFTER

the lifter as herewith illustrated is employed. The oil tanks can be lifted the entire distance between the switch frame and the floor.

The method of removing a tank is as follows: The lifter is placed on the oil switch frame and fastened there by turning 2 wing nuts; the operating handle,

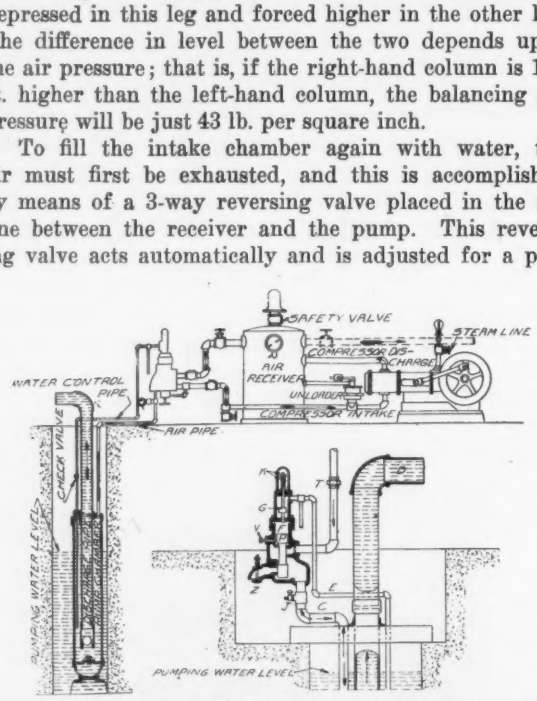
connected to a worm gear, is turned until the 2 triangular tank supports engage the tank, which is then unfastened from the switch frame and lowered to the floor or to any intermediate position desired.

The lifter is adapted to various sizes of the form of switch shown simply by moving slightly forward or back the pulleys over which the cables run, depending upon whether the switch on which the lifter was last used is smaller or larger than the switch next to use it.

Air Displacement Pump

PERHAPS the simplest form of air displacement pump is a "U" tube with inlet and outlet valves. Submerging the tube in water will fill both legs to the same point or level, and if compressed air is applied at the top of one leg of the tube, the water will be depressed in this leg and forced higher in the other leg. The difference in level between the two depends upon the air pressure; that is, if the right-hand column is 100 ft. higher than the left-hand column, the balancing air pressure will be just 43 lb. per square inch.

To fill the intake chamber again with water, the air must first be exhausted, and this is accomplished by means of a 3-way reversing valve placed in the air line between the receiver and the pump. This reversing valve acts automatically and is adjusted for a predetermined water level in the intake chamber. It is controlled either by air pressure or mechanical means. As the object of the controlling device is to maintain a given water seal around the discharge pipe opening, the depression of water in the liquid chamber should not reach beyond this opening before the air is exhausted or all the air would pass out through the discharge pipe and prevent proper operation of the pump.



WEBER AIR DISPLACEMENT PUMP WITH CLOSED EXHAUST SYSTEM

The Weber subterranean pump is of the air displacement type with a discharge pipe and intake chamber which are concentric. Referring to the accompanying illustration, plunger P of the reversing valve in the position shown, allows the admission of air to the pump chamber, B, through pipe C. This air depresses the level of the water, forcing it out through discharge pipe D. A small quantity of water is simultaneously being forced through the ¼-in. pipe, E, which leads to the spring cap of the reversing valve.

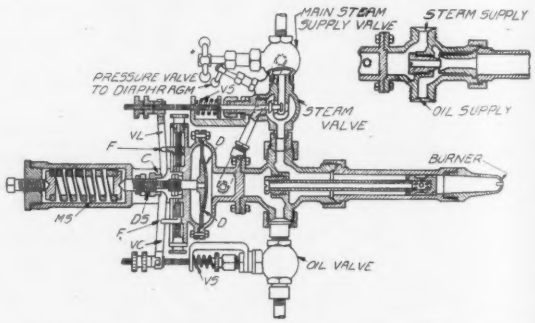
When the water level in the pump chamber is depressed to point A, the compressed air passes up through the ¼-in. pipe, E, to the cap of the reversing valve, acting then upon the spring controlled piston, G, so as to release the small quantity of air above the spool plunger, P. The pressure acting on the bottom of the plunger then drives it to its extreme upper position, cutting off the live air supply and exhausting the air from the pump chamber, B, through air pipe C and then through exhaust port Z. When the exhaust pressure is reduced to zero, the plunger drops to its seat by gravity. During this exhaust interval, the chamber again fills with water due to submergence of the entire chamber.

If the pump is located within 200 ft. of the air compressor, the exhaust air may be returned to the compressor inlet as shown in the illustration. The air cylinder of the compressor then acts partly as a motor to recompress the air into the air receiver. A saving of about 35 per cent of the total power to compress the air shows this type of pump to have a high efficiency for an air operated pump.

By admitting air to the compressor at pressures above the atmosphere, the equivalent free air displacement is increased or a much smaller compressor can be used. The intake valves must be closed or hooded to lead the air under pressure to the cylinder, and in order to restore any loss by leakage or absorption, an automatic unloading drive, X, with check valve in combination, is placed in the intake air line as shown. This pump is manufactured by the Weber Subterranean Pump Co., of New York.

Drago Combination Fuel Oil Burner and Automatic Controller

SUCCESSFUL operation of oil-burning furnaces is, to a great extent, dependent upon the proper control, regulation and atomization of the fuel and the performance of the apparatus employed for that purpose.



SECTIONAL VIEW OF DRAGO COMBINATION FUEL OIL BURNER AND AUTOMATIC CONTROLLER

In the Drago Combination Fuel Oil Burner and Automatic Controller, shown in section in the accompanying illustration, the steam and oil supply is automatically furnished the burner in quantities dependent upon the pressure of the steam with additional provision for manual adjustment. By means of a connection between the main steam supply valve and the

diaphragm casing, the pressure of the steam is allowed to act upon diaphragm D, to which is attached stem DS, working against spring MS. Adjustable cupped collar C on stem DS serves as a means of support for valve levers VL and VC, which communicate any movement of stem DS to the stems of the steam and oil valves provided with springs VS, VS, which in turn tend to keep the discs of these valves upon their seats.

With an increase of steam pressure, diaphragm D moves stem DS toward the left against spring MS, causing valve levers VL and VC to allow the tension of springs VS and VS to act upon the steam and oil valves, thus cutting down the fuel supply until the pressure of the steam drops. With such a pressure drop, diaphragm D, due to the action of spring MS, cause stem DS to move to the right, which in turn, through the medium of collar C and valve levers VL and VC results in a partial opening of the steam and oil valves, an increased supply of fuel, and a consequent raising of the steam pressure.

Fulcrums F and F are adjustable, a feature providing for the desired or required travel of either oil or steam valve; thumb screws at the ends of the steam and oil valve stems provide a further means of adjustments.

By reversing the combining chamber and providing it with nozzles as shown in the upper right-hand corner, this apparatus may be made to act as an injector, creating a suction on the oil line and thus eliminating the necessity of having the oil under pressure.

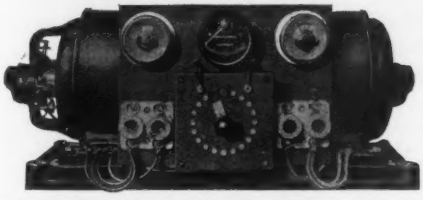
By means of a suitable connection, the burner may be placed at any reasonable distance from the controller.

This burner and controller is patented and manufactured by L. A. Drago, of Seattle, Wash.

Small Battery Charging Equipments

EVERY garage operator and automobile owner has experienced the need of a convenient means for charging small storage batteries, such as are used today on practically all up-to-date gasoline cars for starting, lighting and ignition service. Launch owners, too, have experienced the same need.

For economically charging these small storage batteries, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is marketing an equipment shown in the illustration. This simple, compact motor-generator can be connected to the most commonly found lighting circuits, namely 110 or 220-v., 60-cycle, alternating current, or 115 or 230-v. direct current. The motor generator takes its power from the line and generates direct current at a voltage slightly higher than that of the battery.



WESTINGHOUSE MOTOR-GENERATOR SET FOR BATTERY CHARGING PURPOSES

The panel and the charging set are supplied completely wired ready for operation, which is extremely simple. The motor is first connected to the supply circuit and then started by means of a snap switch. The battery is connected to the generator terminals and the ampere charging rate adjusted by means of the field rheostat to the value shown on the battery name plate. The charging is continued according to the method recommended by the battery manufacturer. As the generator is shunt wound, its voltage increases as the ampere load decreases; that is, as the battery approaches a charged condition, the potential of the generator automatically rises to the higher value required for finishing the charge. This voltage characteristic is a great advantage where lead batteries are to be charged because it permits the operator to give the battery an equalizing or long-period, low-rate charge which prolongs the life of the lead battery.

The Westinghouse charging equipment includes a motor-generator and a charging panel with the necessary controlling rheostat, ammeter, switches and fuses. The ammeter shows the ampere charging rate which can be adjusted by the rheostat. Snap switches and fuses control both the motor, and generator, conforming to all the requirements of the National Board of Fire Underwriters.

The Welderon Receiver Separator

IN steel plate receiver separators as commonly constructed, the separator body as a whole becomes an integral part of the steam header, and as a result, even though built with a sufficient factor of safety, are liable to damage by expansion and contraction stresses. To insure against the possibility of such conditions, the Welderon Receiver Separator has a continuous pipe throughout its length, and all weak points where expansion and contraction stresses might be localized, have been eliminated.

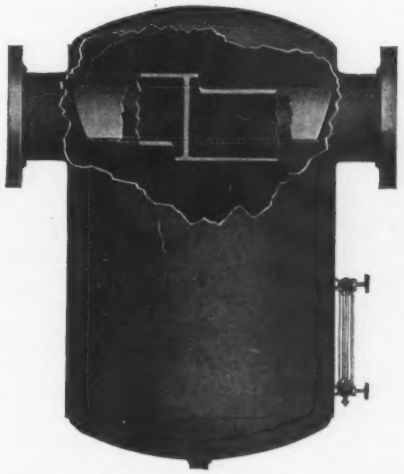


FIG. 1. SECTIONAL VIEW, HORIZONTAL TYPE, WELDERON RECEIVER SEPARATOR

These separators are built in 3 types, the horizontal, the vertical and the angle. In the former, shown in sec-

tion in Fig. 1, steam enters at the left, and passes down into the receiver through the inlet port. The entrainment, due to its high velocity and its greater density, is carried to the bottom of the receiver and the steam, to pass into the steam header again, must circulate around in the receiver and rise to the outlet port in the top of the continuous pipe. Long baffle plates, riveted or welded to the continuous pipe, are so arranged that the steam is deflected, and it is stated to be impossible for any drops of water to reach the outlet, either by being carried along with the steam or by creeping along the pipe.

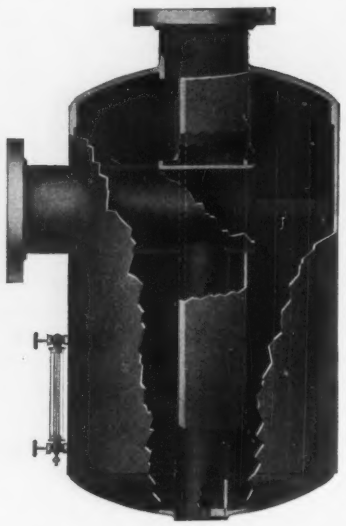


FIG. 2. SECTIONAL VIEW, ANGLE TYPE, WELDERON RECEIVER SEPARATOR

Vertical type Welderon Receiver Separators differ from the horizontal type only in that the continuous pipe is placed centrally parallel to the axis of the separator body.

The angle type of these receiver separators can be adapted for steam inlet at either top or side as desired. In the section shown in Fig. 2, the inlet is at the top and the outlet at the side. The vertical pipe is fitted and welded to the horizontal pipe, and the joint is reinforced by a strong support extending to the bottom of the receiver, as well as by braces to each side. For this type a long baffle plate extending at an angle on each side is attached to the vertical branch of the pipe to prevent particles of moisture from being carried direct to the outlet port, or from creeping around the pipe.

Welderon Receiver Separators are made entirely of open hearth steel plates and wrought steel pipe, with the exception of the cast-steel flanges, which are first screwed on the pipe and then welded in place by a special process. The receiver chamber is made in either riveted or welded construction, or both; but the continuous pipe which forms an integral part of the steam header is in all cases welded to the receiver chamber, thereby insuring an absolutely tight and indestructible joint through which no strains can be transmitted.

Welderon Receiver Separators are manufactured by the Elliott Co. of Pittsburgh, Pa., in sizes ranging from 3½ to 16 in.

All Metal Steam Hose

IN constructing hose that will give dependable service with high-pressure steam under the rough usage to which it is ordinarily subjected in power plant service, several important factors should be considered. It should possess heat-resisting qualities to enable it to withstand the intense heat generated by high-pressure steam. It should have ample strength to ensure long service and should retain its flexibility under steam pressure.

FIG. 1. DOUBLE GROOVE CONSTRUCTION OF METAL HOSE

To withstand the high temperatures of high-pressure steam, the Mulconroy flexible all-metal steam hose is formed on a base of extra heavy, double grooved bronze, which is packed with chemically treated asbestos in order to make every joint steam tight. To insure strength, the next covering is a reinforcement of braided bronze or galvanized steel wires, while an outer armor of spiral half-round galvanized steel affords protection against bending, twisting and dragging over rough surfaces. Details of construction are illustrated in Fig. 1.

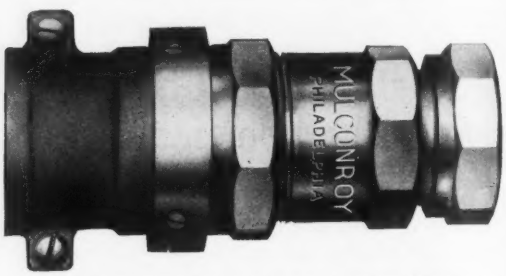


FIG. 2. MULCONROY ALL-METAL HOSE COUPLING

Couplings for this hose are screwed on, and fit into the grooves in such a manner that it is impossible to blow them off. To make a perfect steam joint, these couplings are packed with asbestos and red lead. Both hose and coupling are manufactured by the Mulconroy Co., of Philadelphia, Pa.

AN AMENDMENT to the rules and regulation of the United States Steamboat Inspection Service modifies the provision for the required tensile strength of a test piece in connection with the stays or braces used in marine boilers. The new provision is, that, when the tensile strength of the test piece is more than 63,000 lb. per sq. in. of section, each test piece that has been reduced in size shall show an elongation of at least 26 per cent in 2 in. The former figure for the tensile strength was 66,000 lb.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

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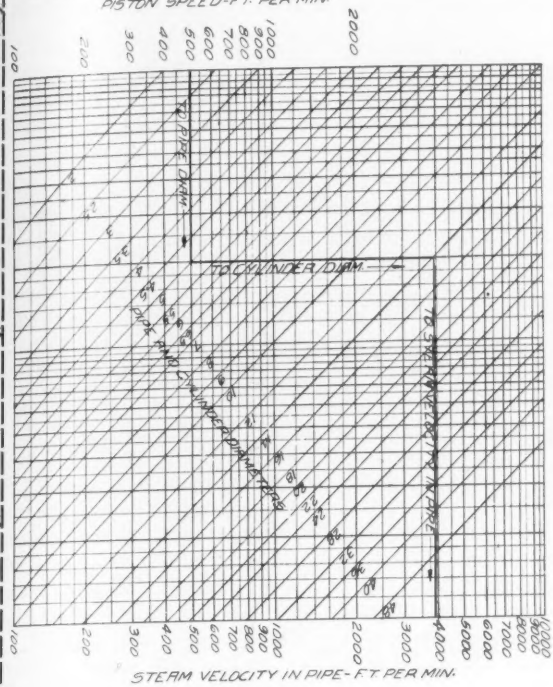
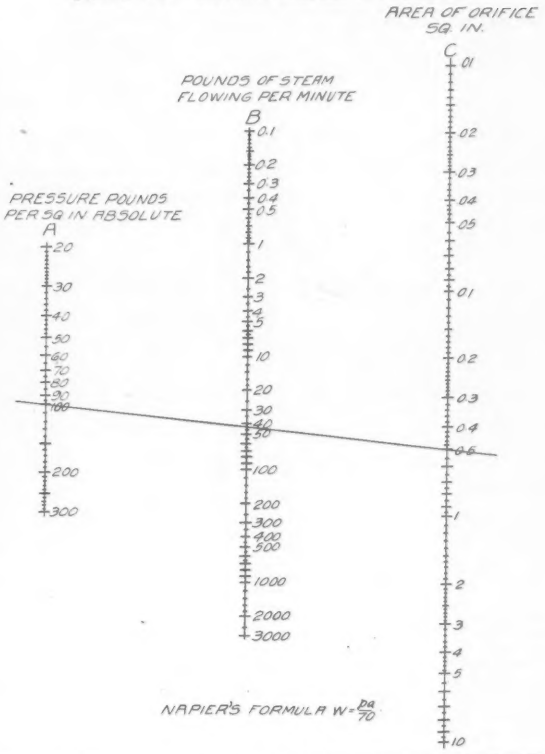
PRACTICAL ENGINEER

RELATION OF PISTON SPEED TO STEAM VELOCITY IN PIPE



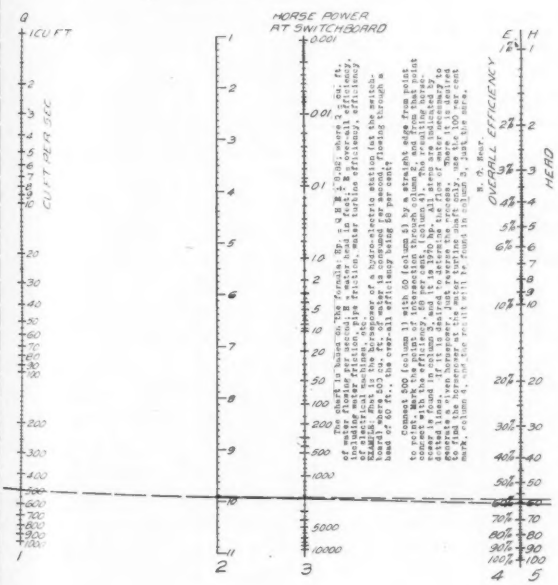
PRACTICAL ENGINEER

CHART FOR SOLVING NAPIER'S FORMULA



PRACTICAL ENGINEER

HYDROELECTRIC CHART

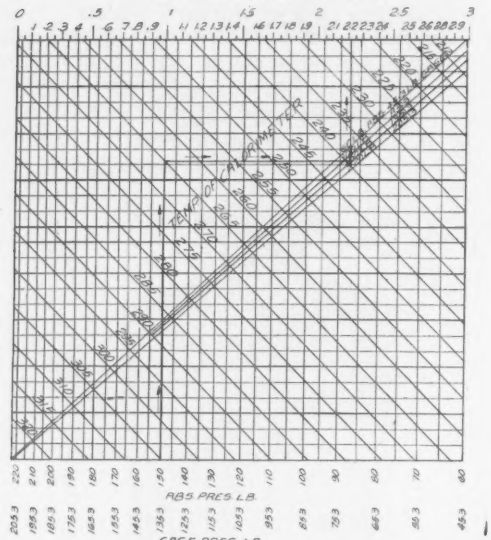


PRACTICAL ENGINEER

LOSSES DUE TO LEAKING BLOWOFF VALVES

Size of Orifice Diam. inch	100 Lb. Pressure				120 Lb. Pressure			
	No. of Gal. Water Wasted Per Mo.	Cost of Coal Per Mo.	Cost of Wasted Water at $0.10 Per 1,000 Gal.	Total Cost Per Mo.	No. of Gal. Water Wasted Per Mo.	Cost of Coal Per Mo.	Cost of Wasted Water at $0.10 Per 1,000 Gal.	Total Cost Per Mo.
1/2	1,905,120	$228.92	$190.51	$419.43	2,160,000	$268.61	$216.00	$484.61
3/8	1,094,400	121.41	109.44	230.85	1,254,240	155.93	125.42	281.35
1/4	476,280	57.23	47.62	104.85	540,000	67.15	54.00	121.15
1/8	119,070	14.31	11.90	26.21	135,000	16.40	13.50	29.90
1/16	29,762	3.60	2.98	6.58	33,750	4.10	3.37	7.47
1/32	7,440	.90	.74	1.64	8,437	1.03	.84	1.87

CHART FOR CALCULATING THROTTLING CALORIMETER FORMULA



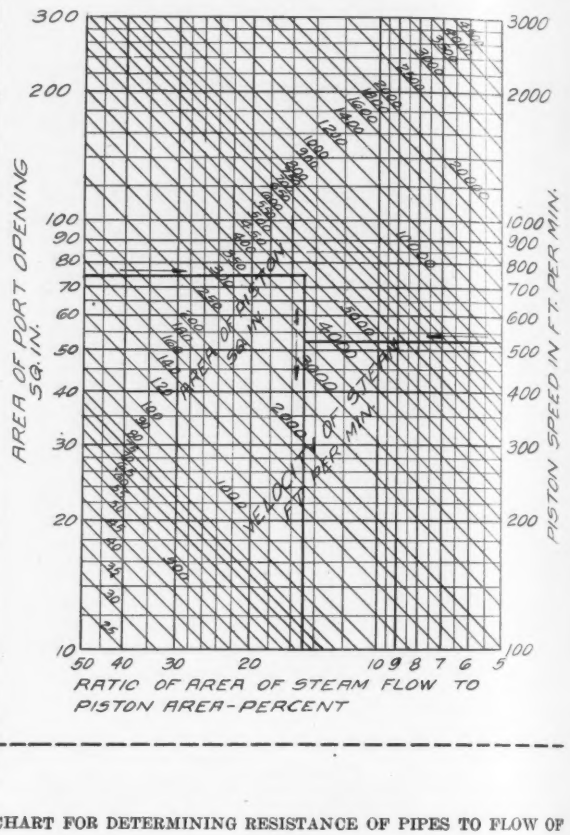
THIS CHART is based on Kent's formula for the throttling calorimeter,

$$W = 100 \times [H - 1146.6 - 0.48\,(T - 212)] \div L.$$

In which W = percentage of moisture in the steam; H = total heat of the steam; T = temperature of the throttled and superheated steam in the calorimeter, deg. F.; L = latent heat of steam in the main pipe.

To use the chart, first note the steam pressure in the pipe and the temperature, T, then enter the chart at the bottom at the proper point in the scale of pressures and trace vertically to the diagonal representing temperature of throttled and superheated steam, then trace horizontally to the right or left, as the case may be, to the diagonal representing pressure, then vertically up to the scale representing percentage of moisture in the steam and read the answer. The heavy line marked with arrows solves the problem where the pressure = 150 lb. abs., and T = 265 deg. F.

RELATION OF PORT AREA TO PISTON AREA AND STEAM VELOCITY

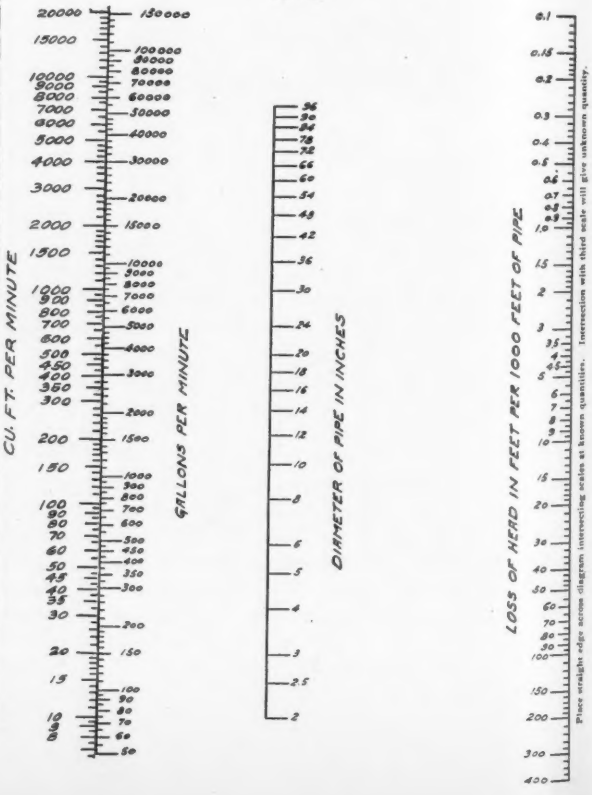


LOSSES DUE TO LEAKING BLOWOFF VALVES

Size of Orifice Diam. inch	150 Lb. Pressure				200 Lb. Pressure			
	No. of Gal. Water Wasted Per Mo.	Cost of Coal Per Mo.	Cost of Wasted Water at $0.10 Per 1,000 Gal.	Total Cost Per Mo.	No. of Gal. Water Wasted Per Mo.	Cost of Coal Per Mo.	Cost of Wasted Water at $0.10 Per 1,000 Gal.	Total Cost Per Mo.
1/2	2,304,000	$307.20	$230.40	$537.60	2,696,416	$399.28	$269.64	$668.92
3/8	1,342,800	179.04	134.28	313.32	1,575,975	268.13	157.59	425.72
1/4	576,000	76.80	57.60	134.40	674,104	99.82	67.41	167.23
1/8	144,000	19.20	14.40	33.60	168,526	24.95	16.85	41.80
1/16	36,000	4.80	3.60	8.40	42,131	6.24	4.21	10.45
1/32	9,000	1.25	.90	2.15	10,533	1.56	1.05	2.61

Calculated by the engineering department of the Homestead Valve Mfg. Co.
Formulas for this table taken from "Kent," Sturtevant "Mechanical Draft." Initial temperature of water taken at 150 deg. F., coal at $2 a short ton, delivered at furnace. 1 lb. coal = 13,000 B.t.u. Waste supposed to go on continuously.

CHART FOR DETERMINING RESISTANCE OF PIPES TO FLOW OF WATER


CU. FT. PER MINUTE
GALLONS PER MINUTE
DIAMETER OF PIPE IN INCHES
LOSS OF HEAD IN FEET PER 1000 FEET OF PIPE
Place straight edge across diagram intersecting scales at known quantities. Intersection with third scale will give unknown quantity.

News Notes

NELSON VALVE Co. and Yarnall-Waring Co. announce the appointment of H. J. Moyer as representative in Chicago, also the opening of their own office in the Hearst Building. A full stock is carried in Chicago.

THE FARNSWORTH MFG. Co., of Boston, Mass., manufacturing tilting traps and duplex boiler feeders, has opened a Chicago office at 20 E. Jackson Blvd., with Charles O. Lindahl as managing District Engineer.

HENRY R. COBLEIGH, formerly mechanical editor of The Iron Age, and latterly managing editor of Power, has established himself in business as a partner in the Power Plant Management Co., National Bank of Commerce Building, New York. A specialty is made of effecting operating economies in power generation and distribution in existing industrial and other plants.

AT THE Second National Exposition of Chemical Industries, to be held at the Grand Central Palace, New York, during the week of Sept. 25, an automatic motion-picture machine of the latest design will be employed to display motion pictures showing machinery and processes in the manufacture of materials. A few of the films to be exhibited are as follows: Making of Black Powder, Manufacture of Iron, Manufacture of Fertilizers, Mining and Manufacturing of Iron, Manufacturing of Silk, Making of Blotting Paper, Silver Mining, Manufacturing of Varnish and Asphalt.

Two other features of the Exposition that have been added this year are a large section showing the opportunities that await the chemist in our South and known as the Southern Opportunity Section and a section devoted to the paper and pulp industry, displaying materials and machinery used in the manufacture of paper and other related products. In addition, the Bureau of Mines is preparing an elaborate working exhibit that will cover much space.

The Exposition will be attended by many of the most prominent men in the industry, and opening addresses are to be made by Dr. Charles H. Herty, President of the American Chemical Society and Chairman of the Exposition Advisory Committee; Francis A. J. Fitzgerald, President of the American Electrochemical Society, and Arthur B. Daniels, President of American Paper and Pulp Association.

The American Chemical Society, whose annual meeting is being held during the same week and in conjunction with the Exposition, has arranged for conference meetings that will take the form of symposiums of an industrial nature.

The American Electrochemical Society has arranged a series of interesting meetings, beginning on Thursday morning, Sept. 28, with the "Made in America" technical session, followed on Friday morning by another session, devoted to the theoretical side of electrochemistry.

The Technical Association of Pulp and Paper Industry also holding meetings in conjunction with the Exposition, is arranging its headquarters in the midst of the Paper and Pulp Industry Section on the second floor of the Grand Central Palace. A large number of interesting papers are promised on the technical aspects of pulp and paper manufacture.

Catalog Notes

A NEW "White Star" valve booklet has recently been published by The Wm. Powell Co., Cincinnati, O.

CONDULETS Bulletin No. 1000E, supplement to Condulet Catalog No. 1000 and Condulet Bulletin No. 1000C, has been received from Crouse-Hinds Co., Syracuse, N. Y.

TYPICAL STOKER LAYOUTS showing the application of Riley self-dumping underfeed stokers to boilers are illustrated and dimension sheets are given in a recent pamphlet from Sanford Riley Stoker Co., Ltd., Worcester, Mass.

THE FOXBORO CO.'S latest bulletin, No. 104, illustrates the company's line of indicating and recording thermometers, describing clearly the actuating principles and recent improvements. This bulletin is now ready for distribution, and may be obtained from the company at Foxboro, Mass.

S. K. F. BALL BEARING CO., of Hartford, Conn., has just issued a new handbook, entitled "Better Electric Motors," on the application of ball bearings to electrical machinery. An accompanying booklet contains letters from electrical engineers telling of results from the use of ball bearings.

THE 1915-1916 ISSUE of the catalog of McGraw-Hill books has been received from the McGraw-Hill Book Co., and is arranged in convenient and attractive form. A very complete index of subjects is provided as well as an authors' index.

The body of the catalog is arranged with the books classified according to subjects so that all books on a given topic are brought together for comparison. The field covered includes all branches of engineering, the book making a handy reference on technical literature of nearly 200 pages.

WATER PURIFICATION for all Purposes is the title of a new catalog which illustrates various types of water softening and purifying apparatus, and discusses water purification as applied to various industrial uses. In it are included analyses from various water supplies throughout the United States and miscellaneous data for calculating water requirements for various uses. The book contains a large number of illustrations showing installations of water purifying apparatus. The manufacturers, Wm. B. Scaife & Sons Co., Pittsburgh, Pa., will be glad to send copies on request.

FROM THE LAGONDA MFG. CO., of Springfield, Ohio, we have just received a catalog of Lagonda Boiler Tube Cleaners which is a handsome and attractive piece of technical literature, printed on a heavy coated stock in two colors, and with particularly clear and interesting illustrations of the Lagonda tube cleaners of different type and the way in which they are operated in various types of boilers and condensers. Full description as well as illustration is given not only of the cleaners, but of other boiler room specialties made by the Lagonda Mfg. Co. The book will be found of interest to everyone who has to do with power plant operation, and a copy will gladly be sent to anyone upon request.

Trade Notes

SOME OF THE recent orders received by The Bruce-Macbeth Engine Co., 2108 Center St., N. W., Cleveland, are as follows: The Faultless Rubber Co., Ashland, Ohio, 1 350-hp., the fourth Bruce-Macbeth gas engine to be installed by this rapidly growing concern, displacing the last steam unit; F. E. Myers & Bros., Ashland, Ohio; Theodore Kundtz, Cleveland, 2 engines, second and third repeat orders within a year; Antler Hotel, Youngstown, Ohio, 1 30-hp.; Eastman Machine Co., Buffalo, 1 40-hp.; Borough of Emporium, Pa., 1 150-hp. Municipal Service, a repeat order, being a duplicate of the Bruce-Macbeth gas engine installed for this city 2 yr. ago, driving elevators in parallel; A. E. Gruber, Pittsburgh, dressed beef market and abattoirs; The James McCord Grocery Co., Fort Worth, Texas, 1 75-hp. for lighting, elevators and refrigeration; Tygart Glass Co., Grafton, W. Va., 1 150-hp., adding one more to the long list of Bruce-Macbeth gas engine in glass factories; Bellview Garage, Milwaukee, Wis., 1 125-hp. producer gas engine, direct connection to generator for lighting and charging storage batteries; Tod House, Youngstown, O., installation consisting of 2 duplicate units for lighting, power and elevator service; American Window Glass Co., Pittsburgh, 1 250-hp., third repeat order; American Extract Co., Port Alleghany, Pa.

THE NORDBERG MFG. CO., of Milwaukee, Wis., now has on order for building a large number of heavy duty hoists, including the following: Steam hoists for Gulf State Steel Co., Birmingham, Ala.; Sulphur Mining & Railroad Co., Richmond, Va.; Davis-Daly Copper Co., Butte, Mont. Air hoists for the Anaconda Copper Mining Co., Butte, Mont (2). Electric hoist for the Elm Orlu Mining Co., Butte, Mont.; Butte & Superior Copper Co., Butte, Mont. (2); Utah Apex Mining Co., Bingham, Utah; St. Louis Smelting & Refining Co., St. Francois, Mo.; Phelps-Dodge & Co., Globe, Ariz.; Phelps-Dodge & Co., Nacozari, Mexico; Federal Mining & Smelting Co., Wallace, Idaho; Hercules Mining Co., Wallace, Idaho; Cerro de Pasco Mining Co., Peru, South America; Furukawa Ashio Mining Co., Japan.

The hoists for the Elm Orlu Mining Co., Butte, and the Butte & Superior Copper Co., Butte, are of particularly large size, the former being a first motion 10-ft. double-drum hoist driven by an 1800-hp. motor, and the second a 12-ft. double-drum first motion hoist, driven by a 3600-hp. motor. These, it is believed, are the largest electric hoists ever built.

The company is also building a large number of its Nordberg-Carels Diesel engines for various mining companies in the West and Southwest.

CONTRACTS for the complete electrical equipment for 3 large double-leaf bascule lift bridges for the City of Seattle, have been awarded to the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa. These bridges will span the Lake Washington Canal and will be among the largest of their type yet built. The electrical equipment for each bridge will consist of 4 100-hp., main operating motors together with a smaller motor for operating the centerlock.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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SEMI-MONTHLY

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Other specified positions, regular rate plus 10 to 50 per cent.

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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

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Technical Publishing Co.

537 S. Dearborn Street

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Position Wanted

POSITION WANTED—Young, sober and reliable married man, as engineer. Six years' experience with a.c. and d.c. compression ice plants, Corliss, high speed and slide valve engines. Ambitious. Desire change where advancement is possible. Open October 1st. R. Bruce, Caruthersville, Mo. 8-15-1

POSITION WANTED—As operating engineer. Over 15 years' practical operating experience with steam and electrical equipment and refrigeration. American; married; use no intoxicants. Age 39. Employed, but desire change. Box 448, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 9-15-1

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Box 436, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 8-1-2

POSITION WANTED—As engineer in pumping station or some stationary plant. Ten years' experience. Capable of taking charge of plant. For further particulars, Engineer, 64 Lawrence St., Hartford, Conn. 8-15-1

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